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# Geology, Energy and Mineral (GEM) Resource Evaluation of the Pioneer Mountains GRA, including the Appendicitus Hill (31-14), White Knob Mountains (31-17), Little Wood River (53-4), and Friedman Creek (53-5) Wilderness Study Areas

Bureau of Land Management
Contract No. YA-553-CT2-1039

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OCTOBER 1983

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# EXECUTIVE SUMMARY

The Pioneer Mountains GRA is located east of Ketchum in south-central Idaho. The area includes four BLM Wilderness Study Areas: Appendicitus Hill (31-14), White Knob Mountains (31-17), Little Wood River (53-4) and Friedman Creek (53-5). The GRA is in the Idaho Falls and Shoshone BLM districts.

There is good geologic data available on the west part of the Pioneer Mountains GRA which includes WSAs 53-4 and 53-5. The data on the east part of the GRA, including WSAs 31-14 and 31-17, is less detailed. The evaluation of oil and gas potential was greatly aided by Nance Petroleum Company who allowed examination of properiety geological and geophysical data from the east part of the area.

The bedrock in the Pioneer Mountains GRA consists of a thick sequence of sedimentary rocks which have been thrust faulted and folded into complex structures. The older rocks are overlain in much of the GRA by younger volcanic rocks. Locally, the sediments are intruded by small igneous stocks. The geophysical data for the area also indicates that several other subsurface intrusive bodies are present.

The Pioneer Mountains GRA includes all or portions of the Copper Basin, Little Wood River, and Lava Creek Mining districts. These areas were active in the late 1800s and early 1900s and produced silver, lead, zinc, copper, gold and barite. There has been intermittent mineral exploration in these distict since active mining ceased. As of June 7, 1982 there were over 1,200 mining claims in the area. Much exploration activity is centered on

the Muldoon area just north of WSA 53-5. Because of this activity field work was done in WSA 53-5 as part of this evaluation. The work shows that favorable geologic structures and geochemical anomalies occur in the Friedman Creek WSA.

The Little Wood River and Friedman Creek WSAs are classified as moderately to highly favorable for metallic mineral resources. All of the WSA have moderate potential for oil and gas. The land classification for the WSAs is summarized in the accompanying table.

# PIONEER MOUNTAINS GRA

## SUMMARY OF GEM RESOURCES CLASSIFICATION

| Resource | Wilderness Study Areas | | | |
|---|---|---|---|---|
| | WSA 31-14 | WSA 31-17 | WSA 53-4 | WSA 53-5 |
| 1. Locatable | | | | |
| a. Metallic Minerals | 2A-3A | 2A-3A | 3C | 4D |
| b. Uranium and Thorium | 2A | 2A | 2B | 2B |
| c. Non-metallic Minerals | 2A-3A | 2A-3A | 3B | 3C |
| 2. Leasable | | | | |
| a. Oil and Gas | 3C | 3C | 3C | 3C |
| b. Geothermal (L) | 1B/2B | 1B | 1B | 1B |
| Geothermal (H) | 1B/2B | 1B | 1B | 1B |
| c. Sodium-Potassium | 2B | 2B | 2B | 2B |
| d. Other (1) | 2B | 2B | 2B | 2B |
| 3. Saleable | 3B | 3B | 2B | 2B |

(1) Includes oil shale, asphalt, phosphate and bitumen.

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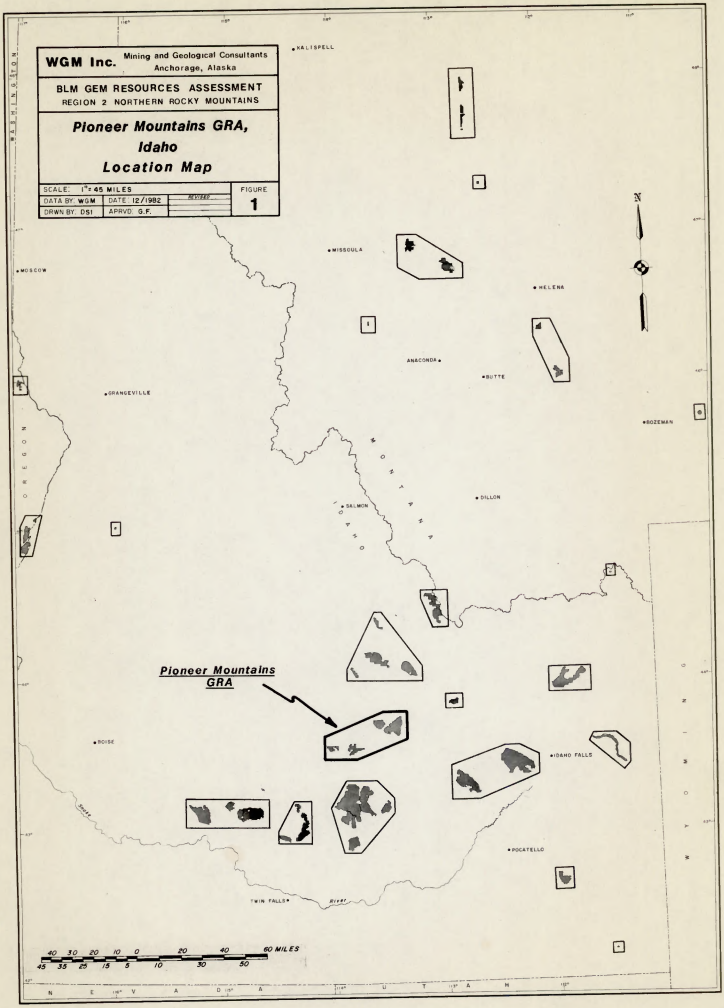
# PIONEER MOUNTAINS GRA

## 1.0 INTRODUCTION

The Bureau of Land Management has adopted a two-phase procedure for the integration of geological, energy and minerals (GEM) resources data into the suitable/non-suitable decision-making process for Wilderness Study Area (WSAs). The objective of Phase I is the evaluation of existing data, both published and available unpublished data, for interpretation of the GEM resources potential of the WSAs. Wilderness Study Areas are grouped into areas based on geologic environment and mineral resources for initial evaluation. These areas are referred to as Geology, Energy, Mineral Resource Areas (GRAs).

The delineation of the GRAs is based on three criteria: (1) a 1:250,000 scale map of each GRA shall be no greater than 8½ x 11 inches: (2) a GRA boundary will not cut across a Wilderness Study Area; and (3) the geologic environment and mineral occurrences. The data for each GRA is collected, compiled, and evaluated and a report prepared for each GRA. Each WSA in the GRA is then classified according to GEM resources favorability. The classification system and report format are specified by the BLM to maintain continuity between regions.

This report is prepared for the Bureau of Land Management under contract number YA-553-CT2-1039. The contract covers GEM Region 2; Northern Rocky Mountains (Fig. 1). The Region includes 50 BLM Wilderness Study Areas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Anchorage, Alaska
BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS
Pioneer Mountains GRA, Idaho
Location Map
SCALE: 1"=45 MILES
DATA BY: WGM
DATE: 12/1982
DRAWN BY: DSI
APRVD: G.F.
REVISED
FIGURE 1
KALISPELL
MISSOULA
HELENA
MOSCOW
ANACONDA
BUTTE
ORANGEVILLE
BOZEMAN
SALMON
DILLON
Pioneer Mountains GRA
BOISE
IDAHO FALLS
POCATELLO
TWIN FALLS
WASHINGTON
OREGON
NEVADA
WYOMING
NEVADA
UTAH
N
40 30 20 10 0 20 40 60 MILES
45 35 25 15 5 10 30 50

totalling 583,182 acres. The WSAs were grouped into 22 GRAs for purposes of the Phase I GEM resources evaluation.

## 1.1 Location

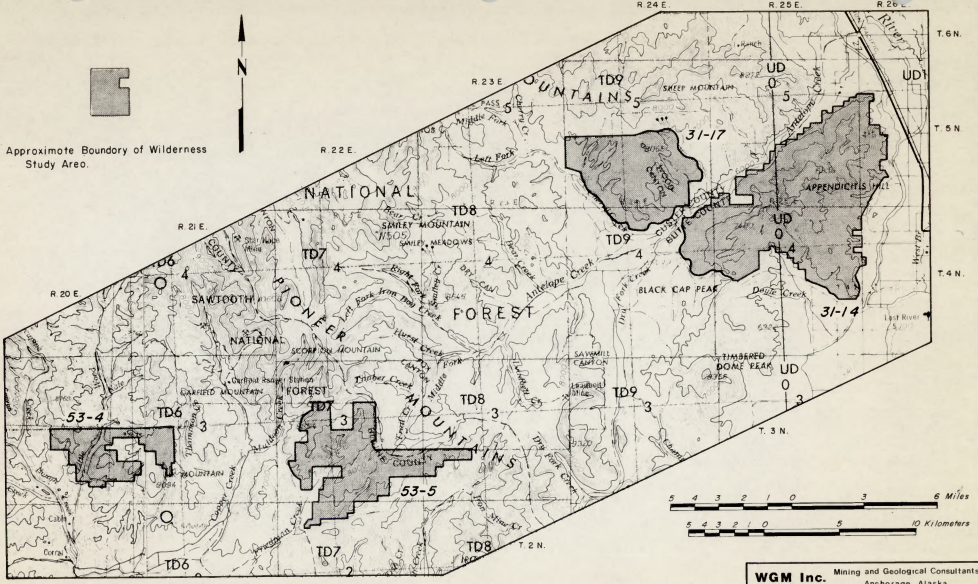
The Pioneer Mountains GRA is located within Ts.2-6N., Rs.20-26E. (Fig. 2), Blaine and Butte Counties, central Idaho (Hailey and Idaho Falls NTMS Quadrangles). The GRA is within the Monument Resource Area of the Shoshone BLM district and the Big Butte Resource Area of the Idaho Falls BLM district. The GRA includes four BLM Wilderness Study Areas (WSAs): Appendicitus Hill (28,870 acres); White Knob Mountains (9,950 acres), Little Wood River (4,385 acres), and Friedman Creek (9,773 acres).

## 1.2 Population and Infrastructure

There are no towns within the Pioneer Mountains GRA. The nearest towns are Arco, five miles east of the GRA, and Hailey and Ketchum 8 and 12 miles west, respectively. State Highway 93 crosses the northeast corner of the GRA. Highway 20 passes 10 miles to the south of the GRA and Highway 75 lies to the west. There are several ranches and numerous gravel roads in the southern and eastern parts of the GRA.

## 1.3 Basis of the Report

This report is based on a compilation, review and analysis of the available published and unpublished data on the geology, energy and mineral resources of the Pioneer Mountains GRA. A number of geological and mineral resource




**BLM Wilderness Study Areas Included in the Pioneer Mountains GRA.**

| WSA | NAME | ACREAGE |
|---|---|---|
| 31-14 | Appendicitis Hill | 24,870 |
| 31-17 | White Knob Mountains | 9,950 |
| 53-4 | Little Wood River | 4,385 |
| 53-5 | Friedman Creek | 9,773 |

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REGION 2 NORTHERN ROCKY MOUNTAINS

***Pioneer Mountains, Idaho***

***Topographic Map***

| | | | |
|---|---|---|---|
| SCALE: 1" = 4 MILES (1:250,000) | | | FIGURE |
| DATA BY: WGM | DATE: 9/1982 | REVISED | 2 |
| DRAWN BY: DSI | APRVD: G.F. | | |

studies have been done in the area. Several of these were detailed studies which provide much useful data. BLM records of oil and gas leases and mining claims were reviewed and records of the Idaho Oil and Gas Commission were searched. WGM geologists spent two days in the field examining the Friedman Creek WSA during October 1982.

The data was compiled and reviewed by WGM project personnel and the Panel of Experts to produce the resource evaluation which comprises this report. Personnel involved in the report preparation are listed below.

| | |
|---|---|
| Greg Fernette, Senior Geologist, WGM Inc. | Project Manager |
| C.G. Bigelow, President, WGM Inc. | Chairman, Panel of Experts |
| Joel Stratman, Geologist, WGM Inc. | Project Geologist |
| Jami Fernette, Land and Environmental Coordinator, WGM Inc. | Claims and Lease Compilation |

Panel of Experts

| | |
|---|---|
| C.G. Bigelow, President, WGM Inc. | Regional geology, metallic and minerals, mineral economics. |
| R.S. Frèdericksen, Senior Geologist, WGM Inc. | Regional geology, metallic minerals. |
| David Blackwell, Ph.D., Professor Geophysics, Southern Methodist University | Geothermal. |
| Jason Bressler, Senior Geologist, WGM Inc. | Regional geology, metallic minerals. |
| Gary Webster, Ph.D., Chairman, Department of Geology, Washington State University | Oil and gas. |
| William Jones, Senior Geologist, WGM Inc. | Metallic minerals, coal, industrial minerals. |
| J.F. McOuat, President, Watts, Griffis & McOuat Ltd. | Mineral economics, and industrial minerals. |

| | |
|---|---|
| E.F. Evoy, Senior Geologist, Watts, Griffis & McOuat Ltd. | Uranium and thorium. |

## 1.4 Acknowledgements

We would like to thank Tim Carroll, District Geologist, Idaho Falls BLM for information on mining claims and mineral occurrences in the eastern part of the Pioneer Mountains GRA. Larry Dee loaned us copies of out-of-print publications and provided much assistance in the compilation phase of the project. We would like to thank Nance Petroleum, Billings, Montana, particularly Fred Brinkman, Vice President, and Keith Mohl, Geologist, for allowing Dr. Gary Webster to examine proprietary exploration data for the eastern part of the Pioneer Mountains GRA.

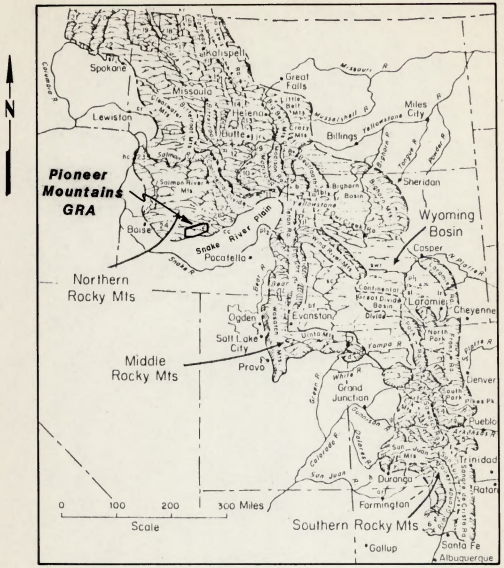
# 2.0 GEOLOGY

## 2.1 Introduction

The geology of the Pioneer Mountains GRA has been mapped by several U.S. Geological Survey workers (Dover, 1969; Nelson and Ross, 1969; U.S. Geological Survey and U.S. Bureau of Mines, 1981). Parts of the area are covered by University of Wisconsin M.S. theses (Bollmann, 1971; Lukowick, 1971; Volkmann, 1971; Wolbrink, 1970; Erwin, 1972). The geologic mapping has been compiled at a 1:250,000 scale by Rember and Bennett (1979a, b). These maps are the basis for Figure 4.

## 2.2 Physiography

The Pioneer Mountains GRA is in the northern Rocky Mountains physiographic province (Hunt, 1974) just north of the Snake River Plain (Fig. 3). The area includes parts of the Pioneer and White Knob Mountains. The topography is characterized by heavily dissected ridges and long structurally-controlled valleys. Drainage in the east half of the GRA is to the northeast via Antelope Creek. In the central part of the GRA drainage is to the south via Muldoon, Friedman and Fish Creeks. The valley floors have elevations of 5,800 to 6,000 feet above sea level. The highest elevation in the GRA is 11,505 feet on Smiley Mountain. The relief on most ridges is typically 1,800 to 2,500 feet.




*Data from: Hunt (1974).*

| | | | |
|---|---|---|---|
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| BLM GEM RESOURCES ASSESSMENT REGION 2 NORTHERN ROCKY MOUNTAINS | | | |
| ***Pioneer Mountains GRA, Idaho Physiographic Setting*** | | | |
| SCALE: AS SHOWN | | | FIGURE 3 |
| DATA BY: | DATE: 3/1983 | REVISED | |
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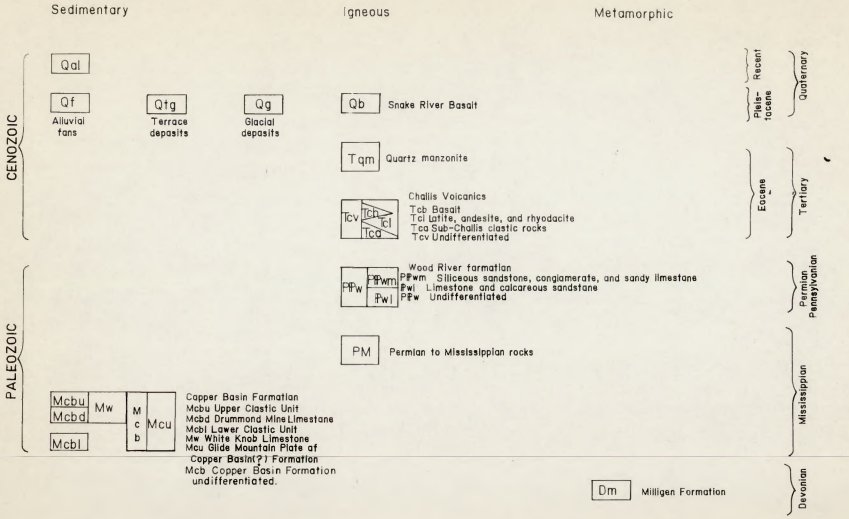
## 2.3 Rock Units

The Pioneer Mountains GRA is in complexly thrust-faulted terrane; thus, the stratigraphy of the underlying rocks has only recently been partially unravelled (Skipp and Hait, 1977; Paull and Gruber, 1977; Dover, 1981). All of the Paleozoic (600-230 m.y.) section is allochthonous. The GRA encompasses parts of the four separate allochthons each of which is characterized by a different Paleozoic stratigraphic succession (Skipp and Hait, 1977); therefore, the Paleozoic rock units will be described for each allochthon. The four allochthons present in the GRA are (southwest to northeast) the: (1) Wood River, (2) Milligen, (3) Copper Basin, and (4) White Knob (Skipp and Hait, 1977). The stratigraphic column for these allochthons is illustrated in Figure 5.

The Wood River allochthon is composed entirely of the Wood River Formation (Fig. 5) which crops out in the west part of the Pioneer Mountains GRA and underlies about half of the Little Wood River WSA. The formation consists of a prominent basal conglomerate, known as the Hailey Conglomerate, about 370 feet thick (Hall et al., 1974). The conglomerate is composed of chert and quartzite pebbles and cobbles interbedded with brown limestone. The bulk of the formation is made up of over 3,000 feet of fine-grained, quartzose, limey sandstone to sandy limestone with quartzite interbeds, siltstone, and dark-gray siliceous argillite with minor easterly derived conglomerate (Hall et al., 1974; Skipp and Hall, 1975). The formation is distinguished by locally abundant fusulinid faunas (Bostwick, 1955; Hall et al., 1974) but also contains crinoid, bryozoan, brachiopod and algae fossils (Skipp et al., 1979). Based on its fossil content a Middle Pennsylvanian

## *Pioneer Mountains GRA, Idaho*
## *Explanation for Figure 4*

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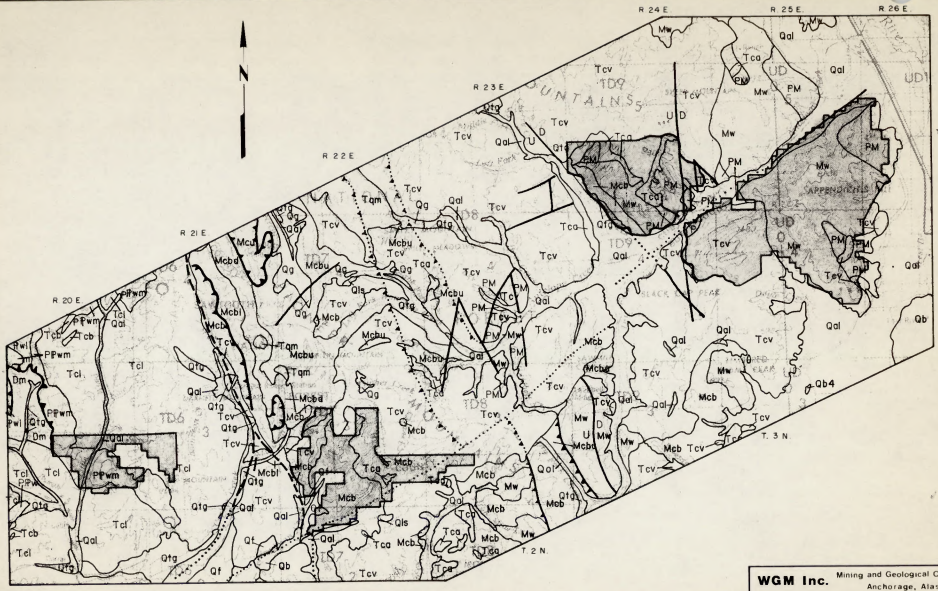
Rember and Bennett, 1979
Rember and Bennett, 1979




5 4 3 2 1 0 3 6 Miles

5 4 3 2 1 0 5 10 Kilometers

Approximate Boundary of Wilderness Study Area.

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REGION 2 NORTHERN ROCKY MOUNTAINS

## Pioneer Mountains, Idaho

## Geologic Map

| | | | |
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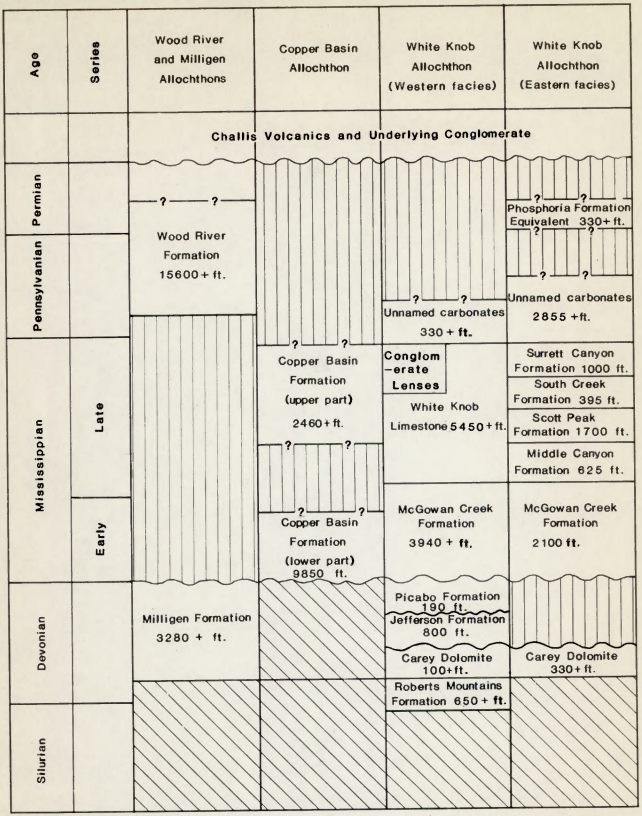


Source: Skipp and Hait, 1977
Skipp et. al., 1979

***LEGEND***

Not Present

Not Known

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REGION 2 NORTHERN ROCKY MOUNTAINS

***Pioneer Mountains GRA, Idaho***

***Stratigraphic Column***

| SCALE | | | FIGURE |
|---|---|---|---|
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(305-290 m.y.) to Early Permian (280-251 m.y.) age is assigned to the Wood River (Skipp and Hait, 1977).

The Milligen allochthon is composed entirely of folded and faulted Milligen Formation (Fig. 5). The Milligen consists dominately of slabby, phyllitic or subphyllitic argillite, and black, thin-bedded to massive, carbonaceous to siliceous, cherty argillite (Dover, 1981). Interbeds of gray, poorly sorted, fine-grained, quartzite, dolomitic siltstone and rare, thin beds of silty micritic to bioclastic limestone occur in the lower part of the unit. The Milligen Formation may be up to 4,000 feet thick, but the thickness is unknown due to structural disturbance. Sandberg et al. (1975) report an Early (395-370 m.y.) through early-Late Devonian (360-345 m.y.) age for the Milligen based on conodont faunas. The unit is interpreted to be a transitional, deep water, oceanic sequence deposited off the toe of a continental slope from a source area to the east (Skipp and Sandberg, 1975).

Like the previous two allochthons the Copper Basin allochthon is composed of a single thick unit, the Copper Basin Formation. The Copper Basin is structurally complicated; thus, its stratigraphic relationships are not completely understood. Dover (1981) divides the Copper Basin into three unnamed members: a lower clastic unit, a medial limestone, and an upper clastic unit.

The basal clastic unit and the medial limestone comprise the lower part of the Copper Basin Formation (Skipp and Hait, 1977). The lower clastic unit is at least 3,200 feet thick and consists of brown to green, medium- to thick-bedded, blocky argillite, and subordinate interbedded dark-gray

quartzite. The argillite is locally laminated and has graded bedding. The quartzite is poorly sorted with an argillaceous matrix and typically contains well rounded, coarse quartz grains or granules of black argillite floating in an argillaceous matrix. Conglomeratic beds with chert and silicerous argillite clasts occur locally (Dover, 1981). The middle limestone unit of the Copper Basin Formation as used by Dover (1981) is equivalent to the Drummond Mine Limestone, a key regional stratigraphic unit (Paull et al., 1972). The unit consists mainly of gray, yellow-brown weathering, slabby to platy, silty micritic limestone, which varies from silty limestone to calcareous siltstone. The rocks are locally silicified and recrystallized (Dover, 1981). The unit is about 2,650 feet thick (Paull et al., 1972). The lower contact of the limestone is gradational through 100 feet or more. Conodont, foraminifera, and ammonite fossils indicate an Early Mississippian (345-332 m.y.) age for the unit (Skipp and Hall, 1975). The Drummond Mine Limestone hosts much of the mineralization in the Copper Basin mining district (Dover, 1981). The lower part of the Copper Basin Formation comprises part of the Antler flysch (Poole, 1974).

The upper clastic unit or upper part of the Copper Basin Formation (Fig. 5) consists predominantly of argillite, gritty sandstone, and granule conglomerate. Graded bedding is common. Groove casts, rip-up conglomerate, cut and fill structures, and convoluted bedding indicate that the unit was deposited in an environment characterized by current scour, turbidity deposition, and sediment slumping. Fossils are scarce and poorly preserved, consequently determination of the age of the unit is tenous. A Late Mississippian (332-310 m.y.) age is assigned based on stratigraphic relations with the underlying Drummond Mine Limestone and correlation with

more closely dated units in the region (Dover, 1981). The thickness of the upper part of the Copper Basin Formation is at least 2,500 feet. The Dry Fork thrust separates the lower and upper parts of the Copper Basin Formation.

The rocks within the White Knob allochthon are divided into a western and eastern facies. The western facies includes rocks ranging in age from Late Silurian (410-395 m.y.) to Pennsylvanian (310-280 m.y.). Rocks ranging in age from Devonian (395-345 m.y.) to Permian (280-230 m.y.) comprise the eastern facies (Fig. 5). The western facies is well exposed in the White Knob Mountains west of the Mackay and the eastern facies is recognized at Antelope Creek and Timbered Dome. The intervening interval between the two facies is covered by the Challis Volcanics; thus, it is possible that the two facies are separated by major faults (Skipp and Hait, 1977).

The oldest unit belonging to the eastern facies is the Late Silurian and Early Devonian Roberts Mountains Formation which is exposed in the Fish Creek Reservoir window (T.1N., R.22E.) about four miles south of the Pioneer Mountains GRA. The Roberts Mountains Formation consists of medium-gray, fossiliferous reef limestone, platy calcareous and dolomitic siltstone, and limestone conglomerate. Its thickness is estimated at about 65 feet (Skipp and Hall, 1975).

An Early to Late Devonian miogeosynclinal shelf carbonate sequence is also exposed in the Fish Creek Reservoir window. This sequence consists of (Fig. 5): (1) the Early and Middle (370-360 m.y.) Devonian Carey Dolomite, a light- to medium-gray, mostly clean, finely crystalline laminated dolomite

about 100 feet thick; (2) disconformably overlain by the Middle and Late Devonian Jefferson Dolomite, an 800 foot thick sequence of dolomite, dolomite conglomerate, and minor sandstone; (3) unconformably overlain by the Late Devonian Picabo Formation, a 190 foot thick sequence of gray fine-grained quartzose and calcareous sandstone, light-gray to pale-yellowish-brown sandy dolomite conglomerate, and minor gray fine-grained dolomite. The top of the Picabo is an unconformity (Skipp and Hall, 1975).

The Cary Dolomite is also present in the Timber Dome area and is the oldest unit exposed in the Pioneer Mountains GRA. In the Timber Dome area, the Carey consists of about 330 feet of interbedded dolomite and quartzite. This area is within the eastern facies of the White Knob allochthon (Skipp and Hait, 1977; Fig. 5).

Early Mississippian rocks unconformably overlie Late Devonian rocks throughout most of Idaho (Skipp et al., 1979) including the Pioneer Mountains GRA. Mississippian rocks have been separated variously by different workers in the area surrounding the GRA. The following descriptions are based primarily on the regional division used by Skipp et al. (1979). Many of these units have been recognized since completion of the detailed mapping of the MacKay Quadrangle (Nelson and Ross, 1969); thus, their distribution has not been mapped in detail throughout the GRA.

The Early and Late Mississippian McGowan Creek Formation is the basal Mississippian unit in the Pioneer Mountains GRA. The McGowan Creek correlates with the lower part of the Copper Basin Formation (Skipp and Hait, 1977; Fig. 5). Regionally, the McGowan Creek consists of a lower

member of orogenic detritus, specifically fine-grained, thinly bedded turbidites, and an upper member of calcareous siltstone interbedded with silty micritic limestone, probably a starved-basin facies. The turbidite sequence ranges from about 100 feet thick in the Beaverhead Mountains to about 4,000 feet thick in the White Knob Mountains (Skipp et al., 1979). In the Timbered Dome area, the McGowan Creek is about 2,100 feet thick (Skipp and Hait, 1977). The upper member of the McGowan Creek ranges in thickness from 200 to almost 500 feet and is present only north and west of Hawley Mountain (about ten miles southeast of the Donkey Hills) (Skipp et al., 1979).

The McGowan Creek Formation is gradationally overlain by the White Knob Limestone. The White Knob is comprised of a lower sequence, about 1,150 feet thick, of interbedded silty micritic mudstone and calcareous siltstone which grades upward into thin- to thick-bedded, medium- to coarse-grained, fossiliferous bioclastic limestone. Eastward pointing tongues of conglomerate and sandstone related to the upper part of the Copper Basin Formation (Fig. 5) are interbedded with the bioclastic limestone in the upper 3,000 feet of the White Knob. Total thickness of the formation is about 5,450 feet (Skipp and Hait, 1977). The lower part of the White Knob represents forebank deposits whereas the upper part of the formation is the westernmost representative of a prograding carbonate bank. Locally abundant fossil evidence from the upper part of the White Knob indicates a Late Mississippian age for the unit (Skipp et al., 1979).

Carbonate bank and forebank deposits equivalent to the White Knob Limestone are divided into the Middle Canyon (oldest), Scott Peak, South Creek, and

Surrett Canyon Formations (youngest) from the White Knob Mountains east to the Montana-Idaho border. These formations represent a prograding carbonate-bank complex which generally thickens westward. Thickness ranges from 1,280 to 4,225 feet and is about 3,720 feet in the eastern part of the Pioneer Mountains GRA. The basal part of the complex, the Middle Canyon Formation, is a non-resistant calcareous sandy siltstone, and silty and sandy limestone weathering reddish brown. In the Pioneer Mountains GRA, the Middle Canyon is about 625 feet thick. It represents in part, the forebank deposit formed in front of the prograding bank; thus, it is correlative with the basal 1,150 feet of the White Knob Limestone. The succeeding Scott Peak Formation (1,700 feet thick in the GRA) and the uppermost Surrett Canyon Formation (1,000 feet thick in the GRA), both thick-bedded medium-dark-gray to dark-gray, variably cherty bioclastic limestones, represent a carbonate-bank accumulation. The intervening South Creek Formation (395 feet thick in the GRA), a thin-bedded dark-gray micritic limestone probably indicates a period of relatively deep water marine circulation that temporarily interrupted carbonate-bank build-up. Fossil evidence indicates that all of the units belonging to the carbonate-bank complex are Late Mississippian in age (Skipp et al., 1979; Huh, 1967).

North of the Snake River Plain in east-central Idaho, about 4,600 feet of interbedded carbonate rocks, sandstone, siltstone and mudstone of latest Mississippian (345-310 m.y.) to Early Permian (280-251 m.y.) age are assigned to the Arco Hills (oldest), Bluebird Mountain, and Snaky Canyon (youngest) Formations. These rocks conformably overlie the Surrett Canyon Formation (Skipp et al., 1979). These rocks correspond to the unnamed carbonates shown in Figure 5.

The Arco Hills Formation is composed of interbedded medium-gray, olive-gray, yellowish-brown, and grayish-red thin-bedded, argillaceous, and silty or sandy limestone, calcareous mudstone or shale, siltstone and minor sandstone, and medium- to thick-bedded pure limestone. The proportion of shale and mudstone in the Arco Hills Formation increases from west to east. No shale or mudstone is present in the southern White Knob Mountains. The unit is a slope-former and is often buried beneath sandstone debris from the overlying Bluebird Mountain Formation. The upper contact with the Bluebird Mountain is sharp and is placed at the base of the stratigraphically lowest thick (12 feet or more) sandstone or siltstone bed. Brachiopods including Orbiculoidea sp., bryozoans, crinoid debris, and calcareous Foraminifera are abundant in the Arco Hills Formation. The Arco Hills is dated as Late Mississippian based on fossil evidence and stratigraphic position. In the southern White Knob Mountains the thickness of the formation is about 110 feet. The Arco Hills is not present in the western facies of the White Knob allochthon (Skipp et al., 1979).

In the Pioneer and White Knob Mountains, the Bluebird Mountain Formation consists of calcareous siltstone, very fine-grained sandstone, and interbedded sandy limestone. The upper contact with the overlying Snaky Canyon Formation is gradational and placed at the position in the section above which limestones are predominate. Foraminifera and the conodonts, Gnathodus bilineathus and Cavusgnathus sp., indicate that the Bluebird Mountain is Late Mississippian. The Bluebird Mountain is 25 feet thick in the southern White Knob Mountains. The thickness the Bluebird in the western facies is probably somewhat less (Skipp et al., 1979).

The Mississippian-Pennsylvanian contact is gradational in the Pioneer Mountains GRA, and the Pennsylvanian rocks are represented by the lower part of the recently defined Snaky Canyon Formation (Skipp et al., 1979) which is comprised of the basal Bloom Member, the succeeding Gallagher Peak Sandstone Member, and the lower part of the overlying Juniper Gulch Member. Only the basal Bloom Member has been recognized in the White Knob allochthon. An incomplete faulted section of the Snaky Canyon at Timbered Dome is 2,855 feet thick (Skipp et al., 1979). Skipp and Hait (1977) report a thickness of 330+ feet for the western facies of the Snaky Canyon. The Bloom Member consists of medium-gray limestone, largely sandy or silty, interbedded with thin beds of very fine-grained, yellowish-brown weathering sandstone and siltstone. Medium- to coarse-grained chert and quartz sandstone, shaly mudstone and siltstone, as well as minor conglomerate are also present in the Bloom Member in the southern White Knob Mountains. Fossil evidence indicates that the Bloom Member spans Early (310-305 m.y.) and Middle Pennsylvanian (305-290 m.y.) time (Skipp et al., 1979).

In the southern White Knob Mountains, along Antelope Creek, at least 164 feet of dark-gray thin-bedded argillaceous and silty limestone, some of it phosphatic, is present in a small graben. The fauna consisting of brachiopods, bryozoans, and mollusks indicate an age (Early Permian) equivalent to the Meade Peak Member of the Phosphoria Formation (Skipp et al., 1979). The contact with the underlying Snaky Canyon is not exposed, but it is presumably conformable.

Mesozoic (240-65 m.y.) clastic rocks rest unconformably on pre-Mesozoic rocks in the Pioneer Mountains GRA. These rocks are mostly pebble- to

boulder-conglomerates composed of well-rounded clasts representing stream gravels and conglomerate or breccia consisting of angular fragments representing talus or other colluvial deposits. The most abundant rock type in these clastic deposits is comprised of quartzite clasts set in a poorly sorted, moderately well cemented quartz-sand matrix. Plant fossils found in the conglomerates indicate a Late Cretaceous (100-65 m.y.) to Paleocene (65-55 m.y.) age for these sediments (Dover, 1981).

The Eocene (55-38 m.y.) Challis Volcanics unconformably overlie the Mesozoic clastics and the Paleozoic rocks in the Pioneer Mountains GRA. The Challis Volcanics are predominantly intermediate flows and tuffaceous rocks (Skipp, 1981). The bulk of the volcanic rocks consist of dark colored porphyritic flows, tuffs and volcanic breccia (Nelson and Ross, 1969). The flows are gray, brown, purple and green hornblende andesites and latites (Dover, 1981). The majority of the Challis Volcanics were extruded between 51 and 45 m.y. ago based on potassium-argon dates (Skipp, 1981).

The layered rocks of the Pioneer Mountains GRA are intruded by two stocks related to the Challis episode of volcanism: (1) the Lake Creek stock and (2) the Muldoon stock (Dover, 1981). The Lake Creek stock is an elongate, northwest-trending body exposed in the north-central part of the GRA (Nelson and Ross, 1969; Fig. 4). The stock is composed of pyroxene-hornblende-biotite quartz monzonite. Phenocrysts of plagioclase, pyroxene and biotite occur in a fine-grained quartz-potassium feldspar matrix. The rock is generally altered. Hornblende is biotitized and biotite is chloritized. The wall rocks are often bleached, silicified and hornfelsed at contacts with the intrusive (Dover, 1981). Armstrong (1975) reports a radiometric

lead age of 50 to 48 m.y. for the stock. Dover (1981) describes contact relations which suggest that the stock is slightly younger than the Challis Volcanics. The Muldoon stock, exposed in two places above Muldoon Creek, is also an elongate northwest-trending intrusive (Fig. 4). It is similar in composition to the Lake Creek stock but has a medium-grained groundmass. Biotite from the Muldoon stock has been dated as 47 m.y. old by potassium-argon methods (Dover, 1981). Small bodies of quartz monzonite present in the Lava Creek mining district may indicate the presence of another near-surface stock (Anderson, 1929).

Rhyolite and andesite dikes occur locally in the Pioneer Mountains GRA (Nelson and Ross, 1969; Dover, 1981). The dikes occur in fracture zones especially those trending northeast and east. Some of the dikes were feeders for the Challis Volcanics.

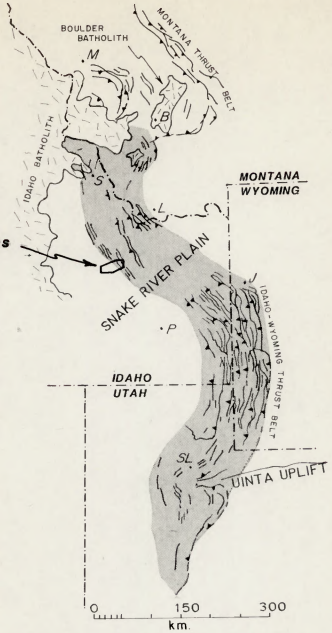
Pleistocene (2-0.1 m.y.) basalt flows which are part of the Snake River Group occur in two areas located on the southern margin of the Pioneer Mountains GRA. These rocks are dark-gray to black, tube-fed pahoehoe lava flows, and bedded moderately oxidized scoria, cinders, and ash (Kuntz, 1978). These flows were fed from a vent located about four miles west of Arco. The lavas rest on and are partly buried by alluvial deposits of late Pleistocene age.

Pleistocene alluvium, glacial and lake deposits overlie all of the rocks in the area. The Pleistocene deposits are dominantly glacial and glacio-fluvial in origin (Dover, 1981). The youngest deposits in the area are Holocene (0.1 m.y. to present) alluvial sediments.

## 2.4 Structural Geology and Tectonics

Regionally the Pioneer Mountains GRA is within the frontal Sevier orogenic belt of the Cordilleran fold-thrust belt (Fig. 6). In the area northwest of the Snake River Plain and east of the Idaho batholith, a minimum of nine major allochthons are recognized including (from west to east): the Wood River, Milligen, Copper Basin, White Knob, Lost River-Arco Hills, Lemhi, Beaverhead, Medicine Lodge and Tendoy allochthons. Each of these allochthons has an internally consistent stratigraphy that differs from adjacent plates. All of the allochthons, except the structurally highest Wood River, are bounded above and below by thrust faults. The allochthons can be grouped into three stacks consisting of: (1) the Pioneer or western stack, structurally the highest, comprising the Wood River, Milligen, Copper Basin and White Knob allochthons, (2) the Lemhi or middle stack comprising the Lost River-Arco Hills, Lemhi, and Beaverhead allochthons, and (3) the Lima or eastern stack, structurally the lowest, comprising the Medicine Lodge and Tendoy allochthons (Skipp and Hait, 1977). The Pioneer Mountains GRA encompasses parts of all the allochthons belonging to the Pioneer stack (Fig. 7).

The Wood River allochthon occupies an area 50 miles long in a north-northwest trending direction. Its western boundary is marked by the eastern edge of the Idaho batholith, and it is about 25 miles wide in the Wood River area. The allochthon is about 3,000 feet thick and is composed entirely of the Wood River Formation (Fig. 5). It has a minimum stratigraphic separation of 9,800 feet with respect to the Milligen Formation in the underlying Milligen allochthon. Facies differences and stratigraphic separation indicate that the Wood River allochthon was transported a minimum distance




Structural trends in the frontal Sevier orogenic belt, (stippled) Utah-Montana. Principal folds trends shown by lines; teeth on major thrust faults. M=Missoula; B=Butte; S=Salmon; L=Lima; P=Pocatello; J=Jackson, SL=Salt Lake City.

Data by: Beutner (1977)

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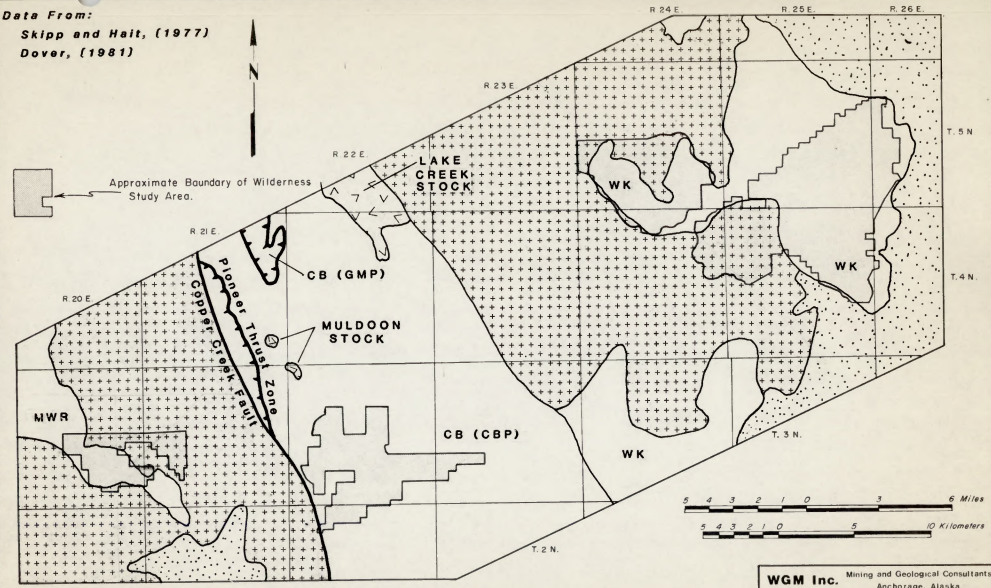
| **WGM Inc.** | Mining and Geological Consultants Anchorage, Alaska |
| BLM GEM RESOURCES ASSESSMENT REGION 2 NORTHERN ROCKY MOUNTAINS | |
| ***Pioneer Mountains GRA, Idaho*** | |
| ***Regional Structural Setting*** | |
| SCALE: AS SHOWN | FIGURE |
| DATA BY: DATE 3/1983 REVISED | 6 |
| DRWN BY: DSI APRVD: G.F. | |


Data From:
Skipp and Hait, (1977)
Dover, (1981)
N
Approximate Boundary of Wilderness Study Area.
R. 24 E.
R. 25 E.
R. 26 E.
R. 23 E.
R. 22 E.
R. 21 E.
R. 20 E.
T. 5 N.
T. 4 N.
T. 3 N.
T. 2 N.
LAKE CREEK STOCK
CB (GMP)
MULDOON STOCK
Pioneer Thrust Zone
Copper Creek Fault
MWR
CB (CBP)
WK
WK
WK
5 4 3 2 1 0 3 6 Miles
5 4 3 2 1 0 5 10 Kilometers
LEGEND
Alluvium
Challis Volcanics
Intrusive Rocks
MWR - Milligan/Wood River Allochthon
CB - Copper Basin Allochthon
(CBP) Copper Basin Plate
(GMP) Glide Mountain Plate
WK - White Knob Allochthon
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Pioneer Mountains, Idaho
Structural Units
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FIGURE
7

of 10 miles on the Wood River thrust. The Wood River allochthon is always associated with the underlying Milligen allochthon; therefore, the two may have moved as a unit during the most recent thrusting (Skipp and Hall, 1975). The Wood River allochthon is deformed and contact metamorphosed by the Late Cretaceous Idaho batholith; thus, latest eastward movement was after Early Permian time and pre-Late Cretaceous. Movement probably occurred during the Sevier orogeny (Hall et al., 1975).

The Milligen allochthon occupies about the same geographic area as the Wood River allochthon. The Milligen allochthon is about 4,000 feet thick and consists exclusively of tightly folded and faulted Milligen Formation. The eastern edge of the allochthon is tightly folded and overturned. The Milligen allochthon is likely thrust over the western part of the Copper Basin allochthon and the lower Paleozoic miogeoclinal carbonates in the Fish Creek Reservoir area. The juxtaposition of Devonian continental rise and miogeoclinal sequences indicates a minimum eastward transport of 30 miles (Skipp and Hait, 1977). If the continental margin occupied a position near the western margin of the Idaho batholith as suggested by Armstrong et al. (1977), then transport of at least 80 miles has occurred (Skipp and Hait, 1977). Regional studies of the Milligen Formation indicate that the unit was deformed and thrust eastward during the Antler orogeny in Late Devonian and Early Mississippian time (Hall et al., 1975). Like the overlying Wood River allochthon, the Milligen allochthon is deformed and thermally metamorphosed by the Idaho batholith; therefore, most recent movement is the same as for the Wood River allochthon, probably Sevier (Skipp and Hait, 1977).

The Copper Basin allochthon extends from Fish Creek Reservoir on the southwest to the eastern flank of Blizzard Mountain (just north of Craters-of-the-Moon) on the southeast. The allochthon is about 12 miles wide and its thickness ranges from 0 just west of Fish Creek Reservoir to 4,500 feet in the southern Pioneer Mountains. The Copper Basin allochthon is imbricated and displaced by N70°E trending tear faults. These faults have left-lateral offset. The allochthon is also cut by normal faults having relative movements of less than 1,000 feet. The latter faults may be caused by Tertiary uplift associated with diapiric structures in the central and southern Pioneer Mountains. The structurally high Glide Mountain plate (Fig. 7) is included in the Copper Basin allochthon. The relatively flat Glide Mountain thrust may override the steeper Muldoon Canyon fault. The sole fault at the base of the Copper Basin allochthon, the Fish Creek-Copper Basin thrust has overriden Late Silurian to Mississippian rocks belonging to the White Knob allochthon. The movement on the Copper Basin allochthon is difficult to estimate, but the complex imbricate thrusting, the great thickness of the Copper Basin Formation, and the tectonically reversed stratigraphic order within the allochthon suggest a minimum eastward transport of 12 miles. On the west, the Copper Basin allochthon is overriden by the Wood River and Milligen allochthons which were in place by pre-Late Cretaceous time (Skipp and Hait, 1977).

The White Knob allochthon extends from the trace of the Copper Basin thrust on the west to the Big Lost River Valley on the east. The basal thrust of the allochthon is not exposed in the Big Lost River Valley, but the fault is needed to explain the facies differences between rocks present in the southern White Knob Mountains and those present in the southern Lost River

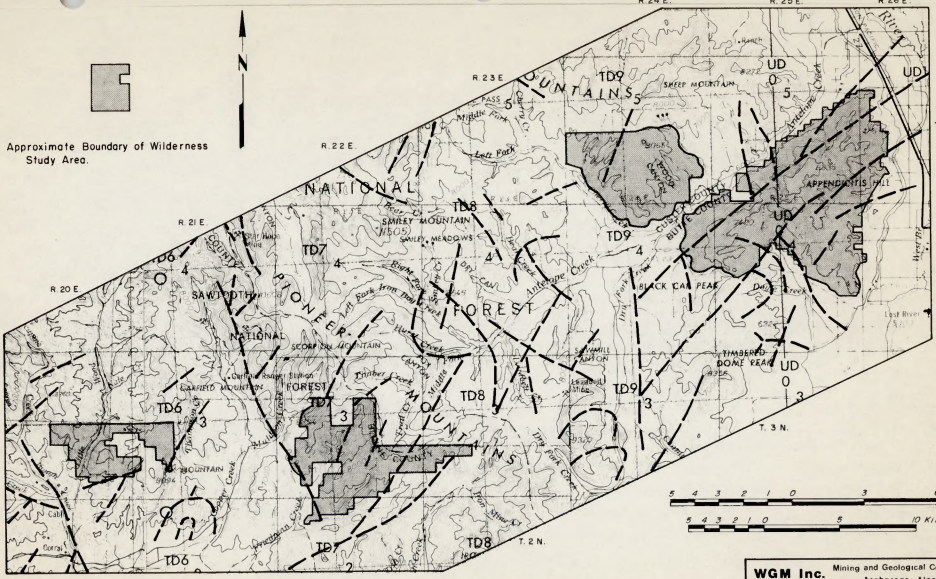
Range. At the surface, the allochthon is 15 to 20 miles wide. The thickness is not known with certainty, but Skipp and Hait (1977) estimate it at 10,000 feet. At the mouth of Antelope Creek, crustal shortening of 40% is estimated for the tight-folding present; thus, a minimum distance of at least 5 miles of eastward transport is inferred. However, an exotic block of granitic gneiss in the Challis Volcanics near Antelope Creek and the presence of high grade Precambrian(?) metamorphic rocks in the structural position of the White Knob allochthon in the central Pioneer Mountains, both suggest that eastward transport may have been much greater. The White Knob allochthon is broken by many north-south and northwest-southeast trending normal faults of basin-and-range affinities (Skipp and Hait, 1977).

Most of the major faults in the Pioneer Mountains GRA form lineaments visible on LANDSAT photos (Fig. 8). Two sets of circular features, one on Dry Fork Creek in the south-central part of the GRA and the other southeast of WSA 53-4, may indicate the presence of near-surface intrusives. Circular fault patterns are associated with buried stocks northeast of the GRA (Ruppel, 1982).

Geologic hazards in the Pioneer Mountains GRA relate mainly to seismicity. The area is just south of the Sawtooth Mountains earthquake swarm (Fig. 9) within the Intermountain Seismic belt (Smith and Sbar, 1974).

## 2.5 Paleontology

Fossils are reported in many of the sedimentary units in the Pioneer Mountains GRA but no special collecting or index localities are reported.




Legend

LINEAMENT

Data from: Ruppel (1982), Mitchell et al., (1980), Day (1974), Haskett (1974).

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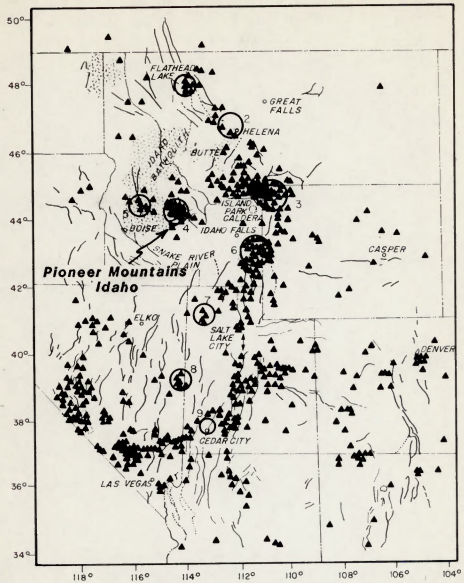
| **WGM Inc.** Mining and Geological Consultants Anchorage, Alaska | |
| BLM GEM RESOURCES ASSESSMENT REGION 2 NORTHERN ROCKY MOUNTAINS | |
| ***Pioneer Mountains, Idaho*** | |
| ***Lineament Map*** | |
| SCALE: 1" = 4 MILES (1:250,000) | FIGURE |
| DATA BY: DATE: 9/1982 REVISED | **8** |
| DRWN BY: DSI APRVD: G.F. | |




EPICENTERS FOR INTERMOUNTAIN SIESMIC BELT SHOWING ALL EARTHQUAKES REPORTED BY NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) OF ABOUT MAGNITUDE 3.0 OR GREATER FROM 1961 THROUGH 1970. DOUBLE ARROW SHOWS ZONE OF LOW SIESMICITY. CIRCLES MARK EARTHQUAKE SWARMS: 1, FLATHEAD LAKE, MONT.; 2, HELENA, MONT.; 3, YELLOWSTONE PARK; 4, SAWTOOTH RANGE, IDAHO; 5, IDAHO BATHOLITH; 6, CARIBOU RANGE, IDAHO; 7, GREAT SALT LAKE DESERT, UTAH; 8, LEHMAN CAVE MONUMENT, NEVADA; 9, CEDAR CITY, UTAH.

DATA FROM: SMITH AND SBAR (1974)

0 70 140 210 MILES
SCALE APPROXIMATE

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| **WGM Inc.** | Mining and Geological Consultants<br>Anchorage, Alaska |
| BLM GEM RESOURCES ASSESSMENT<br>REGION 2 NORTHERN ROCKY MOUNTAINS | |
| ***Pioneer Mountains GRA, Idaho***<br>***Regional Seismicity*** | |
| SCALE: | FIGURE |
| DATA BY: WGM DATE: 3/1983 REVISED | **9** |
| DRWN BY: DSI APRVD: G.F. | |

Conodonts and foraminifera in the Drummond Mine Limestone are significant in determining the age of the Copper Basin Formation (Dover, 1981). Foraminifera, brachiopods, bryozoans and corals are common in the White Knob Limestone and are described in detail by Skipp et al. (1979). Fossil fragments, crinoid columnals, bryozoans, and brachiopods are common in parts of the conglomeratic lower Wood River Formation (Thomasson, 1959). Fusulinids are abundant in some units of the upper part of the Wood River Formation (Hall et al., 1974). Plant fragments are found in the conglomerate at the base of the Challis Volcanics (Paull, 1974).

## 2.6 Historical Geology

Beginning in Middle Devonian a deep basin developed in central Idaho. To the east a miogeosyncline developed which eventually became distinctly differentiated from the semi-stable cratonic shelf along a sharp hinge line near the present Lemhi Range. Seas were regionally transgressive during all of Middle and part of Late Devonian time (Scholten and Hait, 1962).

Latest Devonian to Early Mississippian was a period of upheaval associated with the Antler orogeny. Devonian and older rocks were uplifted and eroded as the Antler highland developed in southwestern Idaho and northern Nevada (Skipp, 1981). Some thrust faulting accompanied the Antler orogeny as indicated by the early movement of the Milligen allochthon (Skipp and Hait, 1977). Turbidites filled a deep and narrow flysch trough developed adjacent to the eastern margin of the Antler highland. East of the flysch trough, thick orogenic, thin starved basin, and thick carbonate sequences were

deposited in an outer cratonic platform or foreland basinal environment. Sedimentation continued without major interruption through Mississippian time (Skipp et al., 1979). The flysch basin had filled by Early Pennsylvanian time and was succeeded by a carbonate bank. Coincident with the rise of the ancestral Rocky Mountains during Middle Pennsylvanian time, the sediments in the western portion of the flysch basin were uplifted to form the Copper Basin highland. Minor coarse detritus from this highland was shed eastward into the shallow water carbonate bank regime of the Snaky Canyon Formation (Skipp, 1981).

The time gap between Permian rocks and the Eocene Challis Volcanics represents the Sevier orogeny. During Early Cretaceous (141-100 m.y.) to Paleocene the major thrust sheets developed forming the allochthonous terrane presently underlying the Pioneer Mountains GRA (Skipp, 1981). Eastward telescoping due to thrusting across the northeast margin of the Snake River Plain is estimated to have produced crustal shortening in excess of 180 miles, and possibly as much as 400 miles. Major thrust movement, at least in the Pioneer Mountains had ceased by Late Cretaceous time when the Idaho batholith was intruded (Skipp and Hait, 1977).

The major part of the Eocene Challis Volcanics was erupted from about 51 to 45 m.y. ago. Minor volcanism and associated intrusive activity continued in the south-central Idaho region until about 40 m.y. ago. Normal and strike-slip faulting proceeded and accompanied volcanism (Skipp, 1981).

After a tectonically relatively inactive period during Oligocene (38-23 m.y.) and early Miocene (23-6 m.y.) time, major basin-and-range extension

faulting commenced about 17 m.y. ago. Eastward tilting of the uplifted fault blocks along moderately dipping normal faults located on their west flank formed the narrow, linear north- to northwest-trending mountain ranges (Skipp, 1981). The inception of basin-and-range faulting was followed closely by the initial downwarping and faulting of the north margin of the Snake River Plain, located south of the Pioneer Mountains GRA (Pankrantz and Ackerman, 1982). Bimodal volcanism related to the development of the Snake River Plain began at least 14 m.y. ago (Christiansen and McKee, 1978) and continued to less than 20,000 years ago (Kuntz et al., 1979).

# 3.0 MINERAL AND ENERGY RESOURCES

## 3.1 Introduction

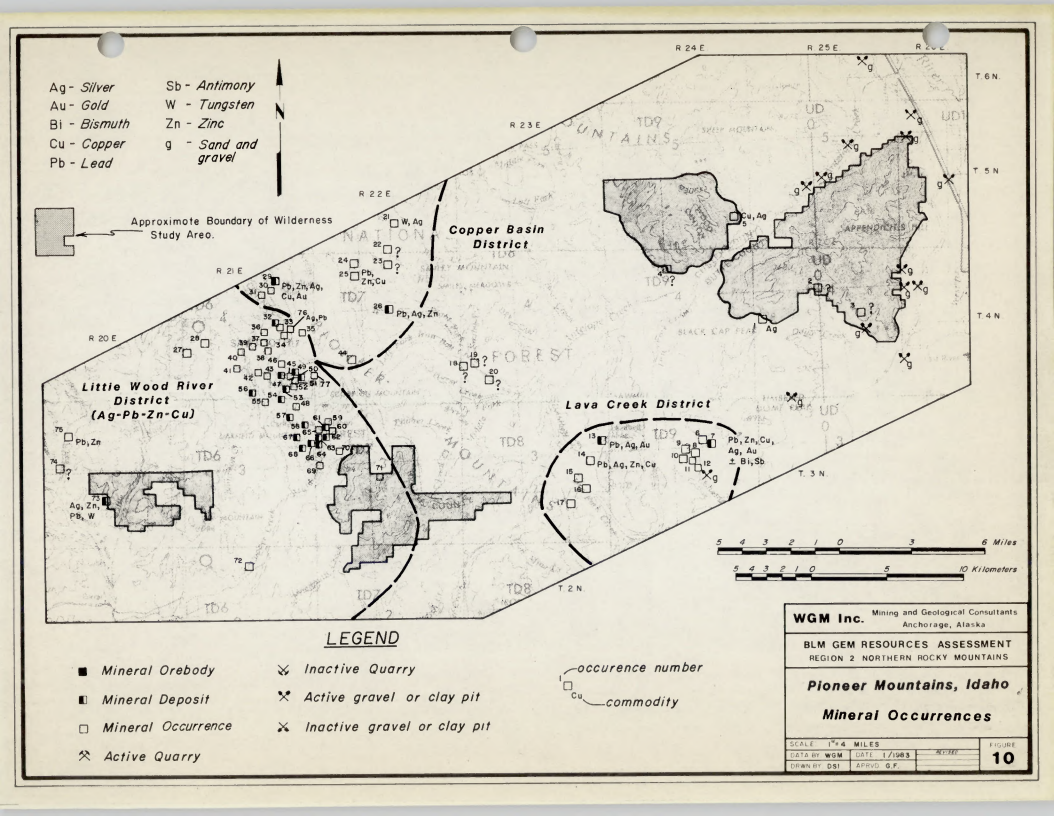
Information on the mineral and energy resources of the Pioneer Mountains GRA was collected from all available sources. General mineral resource data was obtained from the U.S. Geological Survey CRIB File, the U.S. Bureau of Mines MILS File, and the Idaho Bureau of Mines Mines and Prospects Maps Series (Strowd et al., 1981; Hustedde et al., 1981). More specific mineral resource information is available in reports by Anderson (1929), Anderson and Wagner (1946), Finch (1917), Umpleby (1917), and Umpleby et al. (1930). The U.S. Geological Survey and the U.S. Bureau of Mines recently completed an evaluation of the Boulder-Pioneer Wilderness Study Area, which includes the northern part of the GRA (U.S. Geological Survey and U.S. Bureau of Mines, 1981). This report was of great value in this study. Notes on mineral occurrences in the eastern part of the GRA by Tim Carroll also were valuable. Energy resource data was obtained from Breckenridge (1982), the Idaho Oil and Gas Commission, and Mitchell et al. (1980). Nance Petroleum of Billings, Montana kindly allowed WGM to examine data pertaining to the eastern part of the GRA. Two days of field work were completed in the vicinity of the Friedman Creek WSA in October 1982. This work included the collection and analysis of 33 stream sediment samples from streams draining the Friedman Creek WSA.

## 3.2 Known Mineral and Energy Deposits

There are over 70 mineral deposits, prospects, and occurrences in the Pioneer Mountains GRA (Fig. 10, Table I). Most of the deposits are in the Lava Creek, Copper Basin, and Little Wood River mining districts.

The Lava Creek district (Fig. 11), located in the south-central part of the Pioneer Mountains GRA, is described by Anderson (1929). The mines in the Lava Creek district produced about $500,000 worth of silver and lead during 1884-1886. Within the GRA, the district encompasses two groups of deposits; an eastern group on Champagne Creek (loc. 6-12, Fig. 10, Table I) and a western group on Leadbelt and Dry Fork Creeks (loc. 13-14, Fig. 10). About half of the production from the district came from the Hornsilver mine (loc. 4, Fig. 11). The Lead Belt mine (loc. 13, Fig. 10, Table I) has also produced a small amount of silver and lead (Simons, 1981). There is little data on the grade of the ore. Anderson (1929) reports that the ore at the Last Chance mine (loc. 8, Fig. 11) averaged 125 oz/ton silver and 4% copper. Most of the ore in the district was mined from oxidized silver-rich secondary deposits near the surface (Anderson, 1929).

The lodes occur in fissure veins or brecciated zones in volcanics or limestone. Replacement of breccia fragments and wall rocks along vein walls is common. Mineralization consists of argentiferous galena, sphalerite, pyrite, and minor chalcopyrite in a gangue consisting of quartz and locally calcite. The veins range from a stringer up to 12 feet in width. The main vein at the Hornsilver mine averaged four feet in width Alteration often


Ag - Silver
Au - Gold
Bi - Bismuth
Cu - Copper
Pb - Lead
Sb - Antimony
W - Tungsten
Zn - Zinc
g - Sand and gravel
Approximate Boundary of Wilderness Study Area.
Copper Basin District
Little Wood River District (Ag-Pb-Zn-Cu)
Lava Creek District
R 20 E
R 21 E
R 22 E
R 23 E
R 24 E
R 25 E
T. 6 N.
T. 5 N.
T. 4 N.
T. 3 N.
T. 2 N.
Pb, Zn, Ag, Cu, Au
Pb, Ag, Zn
Pb, Zn
Ag, Zn, Pb, W
Pb, Ag, Au
Pb, Ag, Zn, Cu
Pb, Zn, Cu, Ag, Au ± Bi, Sb
Cu, Ag
Ag
W, Ag
Pb, Zn, Cu
5 4 3 2 1 0 3 6 Miles
5 4 3 2 1 0 5 10 Kilometers
LEGEND
Mineral Orebody
Mineral Deposit
Mineral Occurrence
Active Quarry
Inactive Quarry
Active gravel or clay pit
Inactive gravel or clay pit
occurence number
commodity
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Anchorage, Alaska
BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS
Pioneer Mountains, Idaho
Mineral Occurrences
SCALE 1"=4 MILES
DATA BY WGM
DATE 1/1983
DRAWN BY DSI
APRVD. G.F.
REVISED
FIGURE
10

TABLE I

MINERAL OCCURRENCES IN THE PIONEER MOUNTAINS GRA, IDAHO

| Map No. | Name | Commodity | Source of Data |
|---|---|---|---|
| 1 | Mel Johnson placer | Agate | Carroll, 1981 |
| 2 | Unnamed | ? | Carroll, 1981 |
| 3 | Unnamed | ? | Carroll, 1981 |
| 4 | Unnamed | ? | Carroll, 1981 |
| 5 | Espinoza claims | Copper minerals and Agate | Carroll, 1981 |
| 6 | Ella mine | Pb-Zn-Ag-Cu-Au | Anderson, 1929 |
| 7 | Hornsilver mine | Pb-Zn-Ag-Cu-Au + Sb-Bi | Anderson, 1929 |
| 8 | Valley Arco mine | ? | Anderson, 1929 |
| 9 | Reliance mine | Pb-Zn-Bi-Cu-Ag | Anderson, 1929 |
| 10 | St. Louis mine | Pb-Zn-Bi-Cu-Ag | Anderson, 1929 |
| 11 | Oxide Lode prospect | Fe | Anderson, 1929 |
| 12 | Last Chance mine | Zn-Ag-Cu | Anderson, 1929 |
| 13 | Lead Belt mine | Pb-Ag-Au | Anderson, 1929 |
| 14 | Butte-Antelope mine | Pb-Ag-Au-Cu | Anderson, 1929 |
| 15 | Unnamed | ? | Strowd et al., 1981 |
| 16 | Unnamed | ? | Strowd et al., 1981 |
| 17 | Unnamed | ? | Strowd et al., 1981 |
| 18 | Unnamed | ? | Strowd et al., 1981 |
| 19 | Unnamed | ? | Strowd et al., 1981 |
| 20 | Unnamed | ? | Strowd et al., 1981 |
| 21 | Upper Lake Creek | W-Ag | Strowd et al., 1981 |
| 22 | Unnamed | Ag-Pb | Tuchek and Ridenour, 1981 |
| 23 | Unnamed | Ag-Pb | Tuchek and Ridenour, 1981 |
| 24 | Cornhusker group | Pb-Zn-Cu | Strowd et al., 1981 |
| 25 | Candy Cane group | Pb-Zn-Cu | Tuchek and Ridenour, 1981 |
| 26 | Silver Bell | Pb-Ag-Cu | Tuchek and Ridenour, 1981 |
| 27 | Unnamed | Ag-Cu-Pb | Tuchek and Ridenour, 1981 |
| 28 | Unnamed | Barite | Tuchek and Ridenour, 1981 |
| 29 | Star Hope mine | Pb-Zn-Ag-Cu-Au | Tuchek and Ridenour, 1981 |
| 30 | Unnamed | ? | Strowd et al., 1981 |
| 31 | Bent Pine Tree group | Ag-Pb-Zn-Cu | Tuchek and Ridenour, 1981 |
| 32 | Drummond mine | Cu-Au-Pb-Ag | Umpleby, 1917 |
| 33 | Silver Mint Nos. 1 and 2 | Cu-Au-Pb | Tuchek and Ridenour, 1981 |
| 34 | John Larson | Fe-Zn | Strowd et al., 1981 |

| Map No. | Name | Commodity | Source of Data |
|---|---|---|---|
| 35 | Snowball | Pb-Zn | Tuchek and Ridenour, 1981 |
| 36 | Unnamed | Quartz | Tuchek and Ridenour, 1981 |
| 37 | Little Copper Creek vein | Au-Ag | Strowd et al., 1981 |
| 38 | Carrier claim | Pb-Ag-Zn | Strowd et al., 1981 |
| 39 | Copper Bell group | Pb-Ag | Tuchek and Ridenour, 1981 |
| 40 | Unnamed | Ag | Tuchek and Ridenour, 1981 |
| 41 | Trudy B No. 1 | Pb-Zn | Tuchek and Ridenour, 1981 |
| 42 | Unnamed | Au-Pb-Cu | Tuchek and Ridenour, 1981 |
| 43 | Unnamed | Ag-Au-Zn | Tuchek and Ridenour, 1981 |
| 44 | Unnamed | Limonite staining | Tuchek and Ridenour, 1981 |
| 45 | Monarch Fraction | Pb-Ag(?)-Zn | Tuchek and Ridenour, 1981 |
| 46 | John Logan | ? | Tuchek and Ridenour, 1981 |
| 47 | Eagle Bird mine | Ag-Pb-Zn-Cu-Au | Anderson and Wagner, 1946 |
| 48 | Garfield Antimony (Scorpion) | Ag-Pb-Zn | Strowd et al., 1981 |
| 49 | Rippeto | Pb-Ag-Zn | Tuchek and Ridenour, 1981 |
| 50 | Silver Eagle | Ag-Pb-Zn | Tuchek and Ridenour, 1981 |
| 51 | Smuggler | Ag-Pb-Zn | Tuchek and Ridenour, 1981 |
| 52 | Carrier | Zn-Ag-Pb-Cu | Strowd et al., 1981 |
| 53 | Scorpion group | Ag-Pb-Zn | Tuchek and Ridenour, 1981 |
| 54 | Garfield group | Ag-Pb-Zn | Tuchek and Ridenour, 1981 |
| 55 | Silver Spar Mining Co. | Ag-Au-Cu-Zn-Pb | Strowd et al., 1981 |
| 56 | Black Spar | Pb-Ag | Strowd et al., 1981 |
| 57 | Mutual mine | Pb-Ag | Umpleby, 1917 |
| 58 | Boundary Gulch prospect | Ag-Pb-Cu-Zn | Tuchek and Ridenour, 1981 |
| 59 | Grey Eagle | Ag-Pb-Zn | Tuchek and Ridenour, 1981 |
| 60 | Logan tunnel | Pb-Ag | Tuchek and Ridenour, 1981 |
| 61 | Champion and Contact | Cu-Pb | Tuchek and Ridenour, 1981 |
| 62 | Idaho Muldoon mine | Ag-Pb-Zn-Cu | Anderson and Wagner, 1946 |
| 63 | Solid Muldoon | Pb-Zn-Ag | Anderson and Wagner, 1946 |

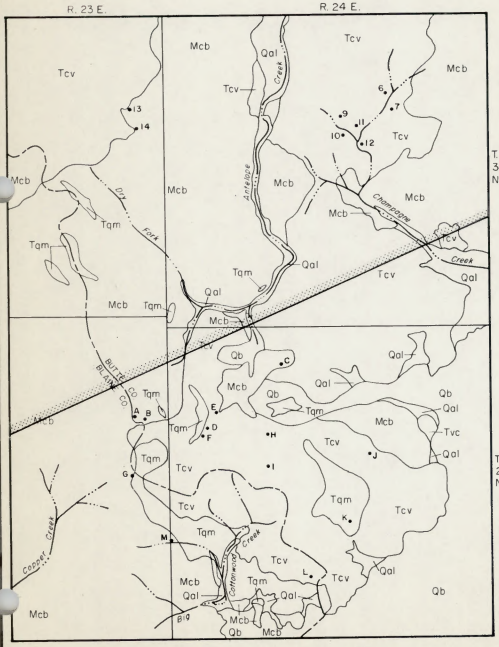
| Map No. | Name | Commodity | Source of Data |
|---|---|---|---|
| 64 | Muldoon mine | Pb-Zn-Ag | Anderson and Wagner, 1946 |
| 65 | American Mine prospect | Pb-Zn | Anderson and Wagner, 1946 |
| 66 | Muldoon Ridge | Au | Strowd et al., 1981 |
| 67 | Boundary and Deep Gulch mines | Ba-Ag-Pb-Zn-Cu | Tuchek and Ridenour, 1981 |
| 68 | Muldoon Barium | Ba | Tuchek and Ridenour, 1981 |
| 69 | Unnamed | Pb-Ag | Strowd et al., 1981 |
| 70 | Lucky Boy | Pb-Ag | Tuchek and Ridenour, 1981 |
| 71 | Lucky Strike | Ag-Pb-Cu | Nelson and Ross, 1969 |
| 72 | Garfield mine | Pb-Ag-Zn-Cu | Strowd et al., 1981 |
| 73 | Silver King mine | Ag-Zn-Pb-W | MILS, 1982; Hustedde et al., 1981 |
| 74 | Unnamed | Ag-Pb | Tuchek and Ridenour, 1981 |
| 75 | Porcupine Creek prospect | Pb-Zn | Hustedde et al., 1981 |
| 76 | Hecla-Carrier | Ag-Pb-Zn | Tuchek and Ridenour, 1981 |
| 77 | Scorpion Ridge No. 1 and 2 | Ag-Pb-Zn | Tuchek and Ridenour, 1981 |

## Legend

| | | | | |
|---|---|---|---|---|
| CENOZOIC | Qal | Alluvium | Recent | Quaternary |
| | Qb | Snake River Basalt | Pleistocene | |
| | Tqm | Quartz monzonite | Eocene | Tertiary |
| | Tcv | Challis Volcanics | | |
| PALEOZOIC | Mcb | Copper Basin Formation (undifferentiated) | | Mississippian |

•10 Location of mine or prospect.

Boundary of Pioneer Mountains GRA.




### Mines and Prospects

13. Lead Belt
14. Butte-Antelope
6. Ella
7. Horn Silver
9. Reliance
11. Oxide Lode
10. St. Louis
12. Last Chance
A. Pandora
B. Sam and Tam
C. Antimony
D. Edna
E. Silver Tip
F. Diamond
G. Wolframite
H. Hub
I. Silver Bell
J. Golden Chariot
K. Marten
L. Copper King
M. Paymaster

*Data from: Anderson, (1929).*

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Anchorage, Alaska

BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

**Pioneer Mountains GRA, Idaho**

**Lava Creek District**

**Geologic Map**

| | | | |
|---|---|---|---|
| SCALE: AS SHOWN | | | FIGURE |
| DATA BY: | DATE: 3/1983 | REVISED | 11 |
| DRWN BY: DSI | APRVD: G.F. | | |

extends for dozens of feet into the wall rock from the veins, especially in the volcanics. Alteration consists of bleaching accompanied by sericitization and lesser silicification. The alteration zone within several feet of the vein is often impregnated with disseminated pyrite which is occasionally accompanied by galena and sphalerite. The ore occurs in small shoots. Few of the shoots were mineable for more than a couple of hundred feet along strike and most of the deposits were mined for only a few dozen feet along strike (Anderson, 1929). Anderson (1929) considers the mineralization to be Tertiary in age and suggests that it may be related to an unexposed granitic body.

The Copper Basin mining district was active during the 1880s and early 1890s. Total production credited to the district is 92 tons of ore with a recoverable content of 2.33 ounces silver per ton, 5.5% copper, 10.4% lead, and 7.1% zinc (Tuchek and Ridenour, 1981). The most productive mine in the district was the Copper Basin or Reed and Davidson (outside of the Pioneer Mountains GRA) which produced 200,000 pounds of copper. The most productive mine within the GRA apparently was the Star Hope mine (loc. 29, Fig. 10, Table I) which produced about $50,000 worth of silver-lead ore (Simons, 1981).

Rocks in the vicinity of the Star Hope mine consist of carbonaceous argillite and quartzite with thin interbeds of limestone intruded by rhyolite and granitic dikes. The sedimentary rocks are folded, generally striking northwest and dipping northeast. Quartz veins in these rocks contain galena, tetrahedrite, and chalcopyrite. The sulfides also occur as

fracture fillings within the vein or as breccia fillings when the vein is brecciated (Tuchek and Ridenour, 1981).

The Little Wood River district has been active intermittently since 1881. Production between 1929 and 1964, the period for which records are available, is summarized in Table II. Earlier production from the principal mine in the district, the Solid Muldoon (loc. 63, Fig. 10, Table I), was about $200,000 worth of silver by 1910. Significant early production amounting to about $130,000 also came from the Eagle Bird mine (loc. 47). In addition, about 2,400 tons of barite was produced from the Muldoon Barium mine (loc. 68). Total production from the district is estimated to have been worth about $330,000 (Simons, 1981). The Little Wood River district includes the western quarter of the Pioneer Mountains GRA, and most of the mineral occurrences are concentrated along Muldoon and Garfield Canyons just north of the Friedman Creek WSA.

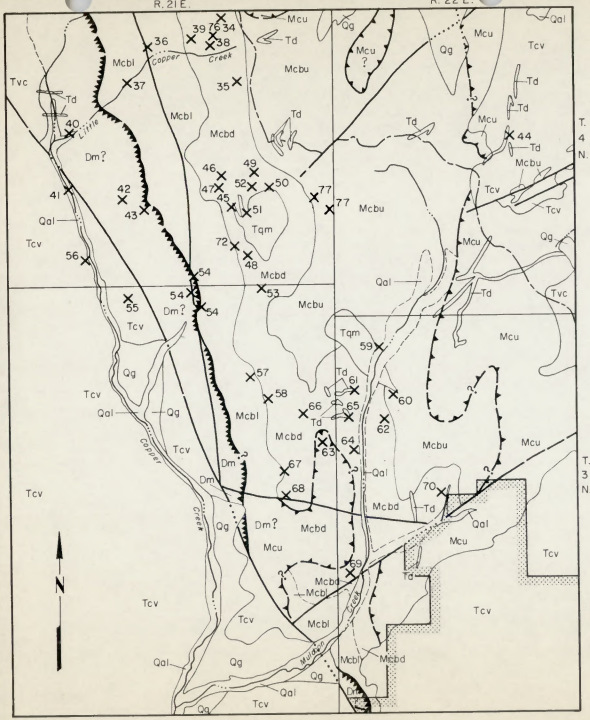
The mineralization in the Little Wood River mining district occurs in Paleozoic limestones and argillaceous rocks, particularly the Drummond Mine Limestone. The mineralization is often spatially associated with Tertiary quartz monzonite stocks and dikes as can be seen by the concentration of mineral occurrences adjacent to two small areas with surface exposures of quartz monzonite (Fig. 12). The Paleozoic rocks in the district are folded along a northwest-trending regional anticline, and the rocks are extensively fractured. The mineral deposits are in generally irregular but well-defined shoots localized at the intersections of bedding-plane faults and high-angle cross faults. The mineralization consists of galena, sphalerite, silver-bearing minerals, chalcopyrite and locally barite. Quartz is the main

TABLE II

RECORDED METAL PRODUCTION 1929-1964, LITTLE WOOD RIVER DISTRICT

| Year | Mine | Ore (t) | Gold (g) | Silver (g) | Copper (kg) | Lead (kg) | Zinc (kg) |
|---|---|---|---|---|---|---|---|
| 1929 | United Mines (Garfield group) | 9 | -- | 2,177 | 14 | 564 | --- |
| 1938 | Eagle Bird | 136 | -- | 5,064 | 95 | 1,164 | --- |
| 1943 | ---do---------- | 27 | -- | 19,562 | 45 | 5,865 | --- |
| 1944 | ---do---------- | 182 | 31 | 60,832 | 294 | 17,357 | 5,653 |
| 1945 | ---do---------- | 336 | 62 | 116,158 | 366 | 33,897 | 2,989 |
| 1946 | ---do---------- | 188 | -- | 44,473 | 171 | 11,478 | 8,402 |
| 1947 | Eagle Bird | 379 | 62 | 106,382 | 503 | 27,445 | 15,610 |
| | Unknown | 47 | -- | 7,464 | 93 | 1,686 | 1,709 |
| 1948 | Eagle Bird | 647 | 93 | 218,571 | 938 | 46,580 | 19,701 |
| 1949 | ---do---------- | 513 | 62 | 158,002 | 606 | 41,024 | 19,958 |
| 1950 | ---do---------- | 791 | 93 | 224,697 | 1,769 | 52,527 | 34,338 |
| 1951 | Eagle Bird | 288 | 62 | 52,791 | 2,525 | 16,705 | 14,026 |
| | Rippeto | 25 | -- | 9,703 | 127 | 4,189 | 273 |
| | Hecla-Carrier | 1 | -- | 902 | --- | 127 | --- |
| 1952 | Eagle Bird | 387 | 218 | 123,280 | 400 | 33,723 | 13,927 |
| | Prince Pine | 1 | -- | 1,[illegible],187 | 283 | 66 | 26 |
| 1953 | Eagle Bird | 149 | 31 | 64,408 | --- | 17,172 | 7,382 |
| 1955 | Scorpion | 1 | -- | 1,306 | 272 | --- | --- |
| 1956 | ---do---------- | 2 | 31 | 529 | 318 | --- | --- |
| 1965 | ---do---------- | 2 | 31 | 1,710 | 560 | --- | --- |
| TOTAL | | 4,111 | 776 | 1,239,117 | 9,539 | 311,369 | 143,994 |

Data from: Tuchek and Ridenour (1981, p. 259).




## Legend

| | | | |
|---|---|---|---|
| Qal | Alluvium | Recent | Quaternary |
| Qg | Glacial deposits | Pleistocene | Quaternary |
| Tqm | Quartz monzonite | Eocene | Tertiary |
| Td | Dike, sills and small intrusive masses that range from rhyolite to andesite. | Eocene | Tertiary |
| Tcv | Challis volcanics | Eocene | Tertiary |
| Mcbu | Mcu: Capper Basin Formation; Mcbu – Upper Clastic Unit | Mississippian | Devonian |
| Mcbd | Mcbd – Drummand Mine Limestone | Mississippian | Devonian |
| Mcbl | Mcbl – Lower Clastic Unit; Mcu – Glide Mountain Plate of Capper Basin (?) Formation. | Mississippian | Devonian |
| Dm | Milligen Formation | Devonian | Devonian |

Outline of Friedman Creek WSA

× 32 Location of mine, prospect, or occurrence.

*For Key to numbers see table* I .

*Data from: U.S. Geological Survey and U.S. Bureau of Mines, 1981.*

.8 .4 0 1 2 MILES
.1 .6 .2 .5

Fault

Thrust Fault

Thrust Zone

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BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

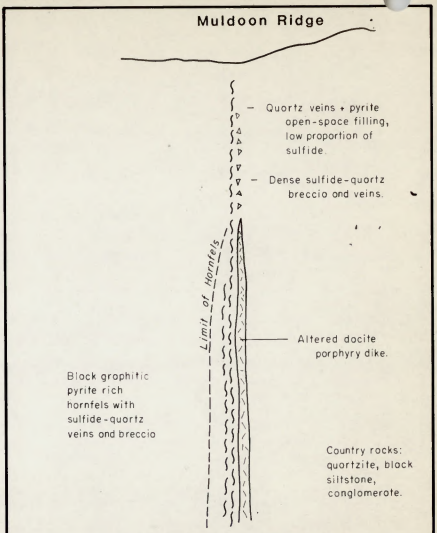
***Pioneer Mountains GRA, Idaho***
***Little Wood River District***
***Geologic Map***

| | | | |
|---|---|---|---|
| SCALE: 1"=1 MILE (1:62,500) | | REVISED | FIGURE |
| DATA BY: | DATE: 3/1983 | | 12 |
| DRWN BY: DSI | APPRV'D: G.F. | | |

gangue mineral, but minor calcite is also present. The mineralization occurs as massive irregular to tabular-shaped replacement lenses, as disseminations, and as fissure fillings in shear zones or in breccias. Replacement bodies are often localized along bedding planes. The most important mines in the GRA are the Solid Muldoon (loc. 63, Fig. 11), the Eagle Bird (loc. 47), and the Muldoon Barium (loc. 68) properties (Tuchek and Ridenour, 1981). Tuchek and Ridenour (1981) also consider the Idaho Muldoon (loc. 62, Fig. 12), Black Spar (loc. 56, Fig. 12), Drummond (loc. 32, Fig. 10), Muldoon Ridge (loc. 66, Fig. 10), Boundary Gulch (loc. 58, Fig. 12), Champion (loc. 61, Fig. 12), Mutual (loc. 57, Fig. 12), Scorpion (loc. 53, Fig. 12), Garfield (loc. 54, Fig. 12), Silver Eagle (loc. 50, Fig. 12), and Rippeto (loc. 49, Fig. 12) properties to have exploration potential.

At the Solid Muldoon mine (loc. 63, Fig. 12), northwesterly striking quartzites and slates are intruded by porphyry dikes. The sedimentary rocks dip moderately to the northeast. A cross section of the geology at the Solid Muldoon mine is shown in Figure 13. A dense brecciated sulfide-quartz vein is present immediately above the altered dacite porphyry dike. This zone grades upward into a zone of open-space filling characterized by quartz and minor pyrite. Adjacent to the dike, the argillites are hornfelsed and pyritized (Anderson and Wagner, 1946). The orebodies consisted of replacement deposits localized along bedding planes and generally adjacent to the dikes. Principal minerals include argentiferous galena, pyrite, sphalerite, and chalcopyrite. A few oreshoots reportedly contained 70% lead across a thickness of 12 to 20 feet. Tenor of the ore apparently decreased with depth (Tuchek and Ridenour, 1981).

*A. Photograph of Solid Muldoon Mine, looking west. (From Tuchek and Ridenour, 1981).*




*B. Schematic sketch of geology.*

100 50 0 100 FEET

APPROXIMATE SCALE

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REGION 2 NORTHERN ROCKY MOUNTAINS

***Pioneer Mountains GRA, Idaho***
***Solid Muldoon Mine***
***Geology***

| | | | |
|---|---|---|---|
| SCALE: AS SHOWN | | | FIGURE |
| DATA BY: | DATE 3/1983 | REVISED | 13 |
| DRWN BY: DSI | APRVD: G.F. | | |

The Eagle Bird mine (loc. 47, Fig. 12) is in medium- to thick-bedded, dark-blue-gray to black, locally siliceous limestones which strike northerly to northwesterly and dip from 30° to 60° northeast. Two principal sets of fractures are present: (1) northwest-trending reverse bedding-plane faults, and (2) westerly to northwesterly high-angle reverse cross faults. The cross faults are marked by locally bleached and limonite-stained zones of fractured rock and gouge. The orebodies occur along or adjacent to two distinct zones of bedding plane faults at or near their intersection with the high-angle cross faults. Galena with lesser amounts of sphalerite, arsenopyrite, complex antimonides, pyrite and local chalcopyrite occurs in massive irregular to tabular shaped replacement bodies. Disseminated mineralization is also present. The lenticular sulfide masses attain thicknesses up to 3 feet and may extend for tens of feet along strike and down-dip. The near-surface orebodies are oxidized. Alteration of the host rock consists mainly of a softening and bleaching of normally resistant limestone. Locally, more intense alteration produces a creamy-white marble (Tuchek and Ridenour, 1981).

The barite at the Muldoon Barium mine (loc. 68, Fig. 12) occurs in three irregular veins ranging from 1.5 to 14 feet thick. One vein may be up to one mile long. A silver-lead-zinc vein occurs nearby (Tuchek and Ridenour, 1981). According to Tuchek and Ridenour (1981), the property was active in 1974 and 4,000 tons of ore were stockpiled. Simons (1981) reports the occurrence of barite talus along with anomalous barium values in geochemical samples from the ridge between Muldoon Canyon and Argosy Creek east of the mine. This area is just west of the boundary of WSA 53-5.

## 3.3 Known Mineral and Energy Prospects, Occurrences, and Mineralized Areas

A number of other silver-lead-zinc-copper prospects, occurrences, and mineralized areas are known in the Pioneer Mountains GRA. Most of these consist of either vein or replacement mineralization and exhibit the same style of mineralization as the deposits discussed in the previous section; thus, additional discussion of these prospects is unnecessary. These occurrences are tabulated in Table I and shown on Figure 10. A number of the occurrences shown on Figure 10 (locs. 15-20, 30 and 69) were compiled from 15 minute topographic quadrangle maps by Strowd et al. (1981) and little other information is available. Iron Bog Creek which drains three of these occurrences (loc. 18-20) has anomalous lead contents in stream silt samples (Simons, 1981). Three occurrences (locs. 2-4) consist of prospect pits or shafts noted in Bureau of Land Management files (Carroll, pers. comm., 1981), but no other information is known.

Bureau of Land Management internal files (Carroll, pers. comm., 1981) also show two groups of claims (locs. 1 and 5, Fig. 10) which encompass agate occurrences. One of these occurrences, the Espinoza claims (loc. 5), also has some evidence of copper mineralization. Little else is known about these two occurrences.

To evaluate the potential for base-precious metals mineralization along northwest-trending structures which may project into the Friedman Creek WSA, thirty-three stream sediment samples were collected from streams draining the WSA (Appendix III). The analytical data was compared with the data from the Boulder-Pioneer Study Area (Simons, 1981). Using the same threshold

values determined by Simons (1981), eleven samples are anomalous in one or more of the following elements: copper, lead, zinc, and silver (Table III). The anomalies (Fig. 14) occur mainly in valleys with outcropping Paleozoic rocks, although the strong multi-element anomaly at the head of Friedman Creek is underlain by Challis Volcanics. The stream sediment survey outlined eight drainage basins which wholly or partly overlap the WSA and have anomalous lead, zinc, copper, and/or silver contents in their stream sediments. These basins range from slightly less than one-quarter square mile to almost one square mile in area.

There are twelve gravel pits in the eastern part of the Pioneer Mountains GRA (Strowd et al., 1981). The gravel pits are probably utilized on an as-needed basis for local sand and gravel supplies.

## 3.4 Mining Claims, Leases and Material Sites

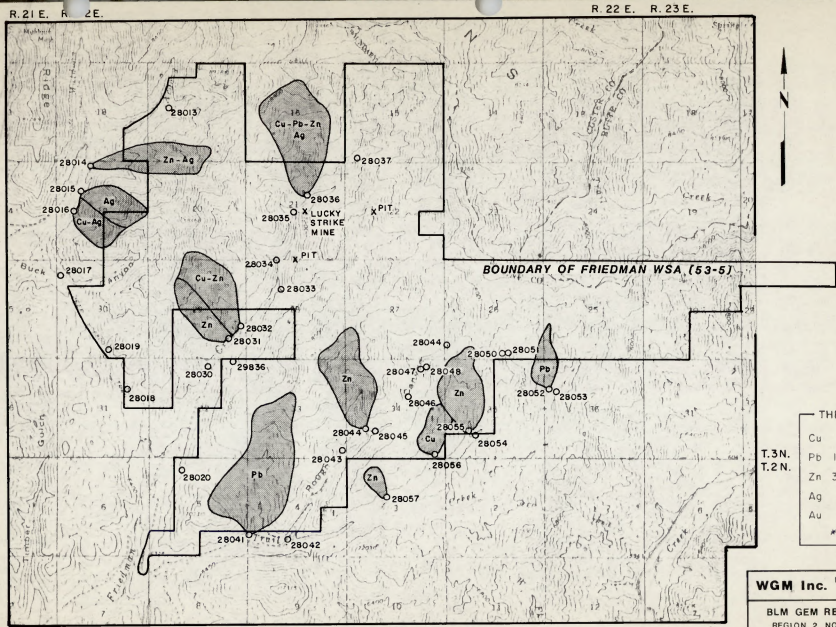
A review of BLM claims records current to June 7, 1982 and mineral title plats current to August 12, 1982 shows that there are a total of 1,275 unpatented mining claims and 42 patented mining claims in the Pioneer Mountains GRA (Fig. 15). The majority of the claims are in the Lava Creek and Little Wood River mining districts. About 30 claims are located in or immediately adjacent to the eastern part of the Little Wood River WSA and several claims may overlap the northwest corner of the Friedman Creek WSA. The majority of the patented claims are in the Little Wood River mining district.

TABLE III

ANOMALOUS* GEOCHEMICAL SAMPLES, FRIEDMAN CREEK WSA

| Sample No. | Type | Cu (ppm) | Pb (ppm) | Zn (ppm) | Ag (ppm) | Au (ppm) |
|---|---|---|---|---|---|---|
| 28014 | Silt | 55 | 45 | 345 | 4.0 | 0.02 |
| 28015 | Silt | 65 | 50 | 195 | 2.2 | 0.02 |
| 28016 | Silt | 95 | 50 | 135 | 2.2 | 0.02 |
| 28031 | Silt | 45 | 45 | 390 | 0.2 | 0.04 |
| 28032 | Silt | 90 | 60 | 500 | 1.2 | 0.04 |
| 28036 | Silt | 335 | 335 | 450 | 5.0 | 0.10 |
| 28041 | Silt | 40 | 175 | 145 | 1.0 | 0.02 |
| 28044 | Silt | 60 | 55 | 465 | 1.0 | 0.04 |
| 28052 | Silt | 50 | 170 | 140 | 0.8 | 0.02 |
| 28055 | Silt | 45 | 35 | 465 | 0.4 | 0.02 |
| 28056 | Silt | 140 | 60 | 150 | 1.0 | 0.02 |
| 28057 | Silt | 45 | 40 | 400 | 0.4 | 0.02 |

* Based on threshold values determined by Simons (1981).




THRESHOLD VALUES*

| | |
|---|---|
| Cu | 70 ppm |
| Pb | 100 ppm |
| Zn | 300 ppm |
| Ag | 1.5 ppm |
| Au | 0.1 ppm |

*from: Simons (1981)

Legend

○ 28050 Stream sediment sample site.

Cu Area of influence of sample and anomalous elements.

.8 .4 0 1 2 MILES
1 .6 .2 .5

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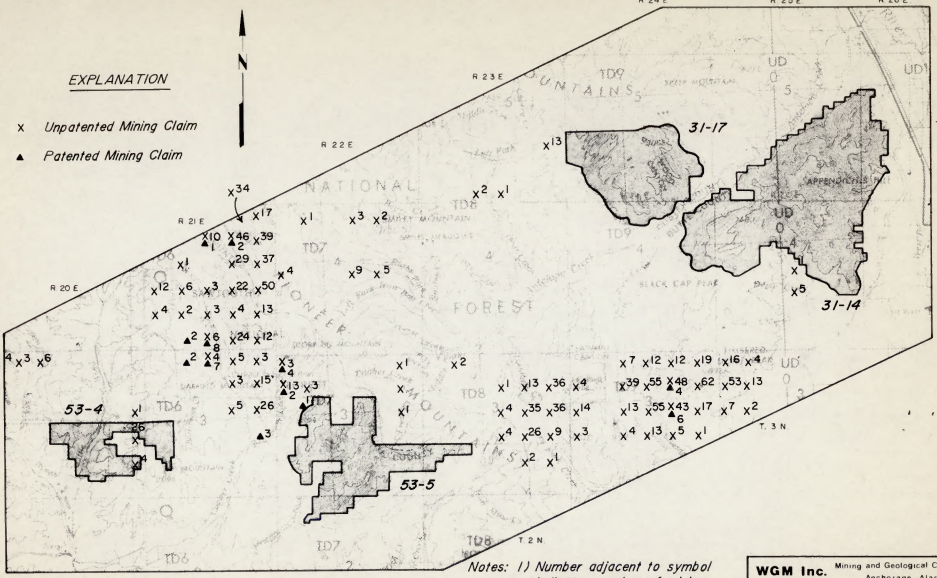
BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

**Pioneer Mountains GRA, Idaho**

**Geochemical Anomalies**
**Friedman Creek WSA**

| | | | |
|---|---|---|---|
| SCALE: 1"=1 MILE (1:62,500) | | | FIGURE |
| DATA BY: WGM | DATE: 3/1983 | REVISED | 14 |
| DRWN BY: DSI | APRVD: G.F. | | |




Notes: 1) Number adjacent to symbol indicates number of mining claims in that section.

2) Area of search: Entire GRA

3) Source of Data: BLM Claims Microfiche and MT Plats.

4) Data current to: June 6, 1982.

Approximate Boundary of Wilderness Study Area.

5 4 3 2 1 0 3 6 Miles

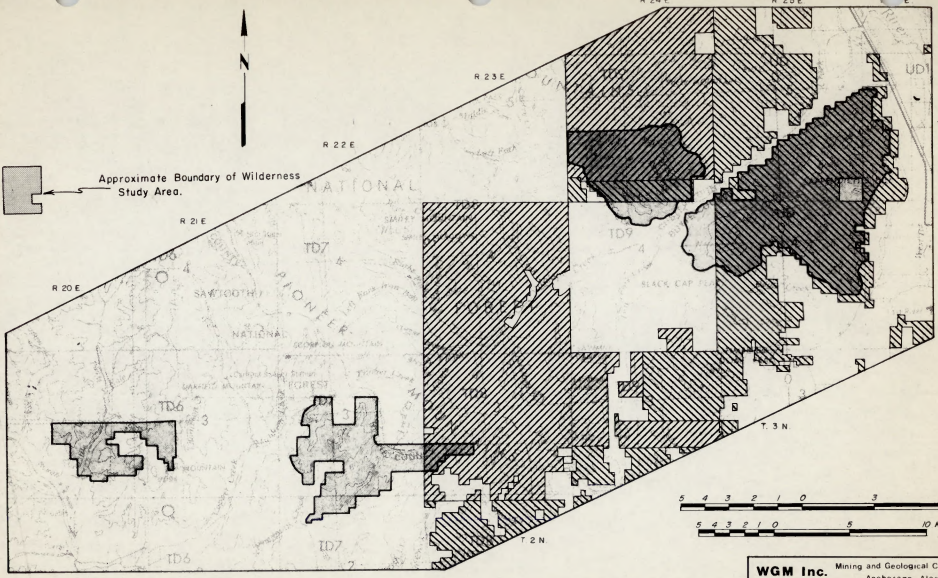
5 4 3 2 1 0 5 10 Kilometers

| | |
|---|---|
| **WGM Inc.** | Mining and Geological Consultants Anchorage, Alaska |
| BLM GEM RESOURCES ASSESSMENT REGION 2 NORTHERN ROCKY MOUNTAINS | |
| **Pioneer Mountains, Idaho** | |
| *Mining Claims Density Map* | |
| SCALE 1"=4 MILES | FIGURE 15 |
| DATA BY WGM DATE 1/1983 | |
| DRWN BY DSI APRVD. G.F. | |

BLM oil and gas plats current to August 12, 1982 show that much of the eastern half of the Pioneer Mountains GRA is covered by oil and gas leases and lease applications (Fig. 16). Most of the Appendicitis Hill WSA and about 15% of the White Knob Mountains are covered by oil and gas leases (Table IV). About 50% of the White Knob Mountains WSA and about 10% of the Friedman Creek WSA are covered by oil and gas lease applications.

## 3.5 Mineral and Energy Deposit Types

The most obvious metallic mineral potential in the Pioneer Mountains GRA is for silver-lead-zinc-copper deposits similar to the known occurrences discussed in Section 3.2. Similar deposits are common along the east flank of the Atlanta lobe of the Idaho batholith (Bennett, 1980) and in the fault block ranges east of the batholith (Ruppel, 1978; 1982). Examples are the Bayhorse (McIntyre et al., 1976; Ross, 1937), Gilmore (Ruppel et al., 1970), Lava Creek, (Anderson, 1929; Ross, 1931), Little Wood River (Nelson and Ross, 1969; Tuchek and Ridenour, 1981) and the Copper Basin (Tuchek and Ridenour, 1981) districts. The mineralization in these districts consists of irregular veins and replacement bodies in folded and faulted sedimentary and metamorphic rocks and to a lesser extent in intrusive rocks. Quartzite, argillite, limestone and dolomite are common host rock lithologies, however limestone and dolomite are the most abundant hosts (Hobbs, 1968). Argentiferous galena and sphalerite with lesser amounts of pyrite and chalcopyrite are the principal metallic sulfide minerals. The deposits are commonly oxidized at the surface and much of the early production consisted of high-grade secondary silver-lead-zinc ores. The mineralization is associated




LEGEND

Area covered by oil and gas leases.

Area covered by oil and gas lease application.

Notes: 1) Area of Search: Entire GRA
2) Data current to: Aug. 12, 1982
3) Source of Data: BLM O.G. Plats

**WGM Inc.** Mining and Geological Consultants Anchorage, Alaska

BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

**Pioneer Mountains, Idaho**

**Oil and Gas Lease Status**

| | | | |
|---|---|---|---|
| SCALE 1"=4 MILES | | | FIGURE |
| DATA BY WGM | DATE 1/1983 | REVISED | 16 |
| DRWN BY DSI | APRVD. G.F. | | |

WGM Inc.

TABLE IV

OIL AND GAS LEASES IN WSAs 31-14 AND 31-17

| WSA | Lease No. | Owner of Record | Date Issued |
|---|---|---|---|
| 31-14 | I 16602 | Ronan Inc.<br>P.O. Box 1354<br>Billings, Montana 59103 | 12-01-81 |
| | I 16697 | Ronan Inc.<br>P.O. Box 1354<br>Billings, Montana 59103 | 10-01-81 |
| | I 16728 | Pioneer Production Corp.<br>P.O. Box 2542<br>Amerillo, Texas 79189 | 07-01-81 |
| | I 17034 | Wolter Oil Company<br>P.O. Box 8686<br>Boise, Idaho 83707 | 10-01-81 |
| | I 17796 | Thomas D. Hewitt<br>915 Gulf Canada Square<br>Calgary, Alberta, Canada | 01-01-82 |
| | I 18237 | Ronan Inc.<br>P.O. Box 1354<br>Billings, Montana 59103 | 05-01-82 |
| 31-17 | I 18165 | Ronan Inc.<br>P.O. Box 1354<br>Billings, Montana 59103 | 10-06-81<br>(applic. filed) |
| | I 18189 | Hewitt Producing Company<br>915-401 9th Avenue S.W.<br>Calgary, Alberta, Canada<br>T2P 3C5 | 07-01-82 |
| | I 18190 | Hewitt Producing Company<br>915-401 9th Avenue S.W.<br>Calgary, Alberta, Canada<br>T2P 3C5 | 10-19-81<br>(applic. filed) |
| | I 18194 | Hewitt Producing Company<br>915-401 9th Avenue S.W.<br>Calgary, Alberta, Canada<br>T2P 3C5 | 10-19-81<br>(applic. filed) |
| 53-5 | I 18440 | John R. Warne 3/8 interest<br>Irvin Kronzler "<br>Robert C. Balson "<br>Box 1324<br>Billings, Montana 59103 | 12-24-81 |

with Tertiary intrusive bodies (Bennett, 1980). These rocks are often hydrothermally altered and contain disseminated sulfides (Ruppel, 1982).

Tungsten occurs in a few of the silver-lead-zinc districts mentioned above as an accessory. Cook (1955) delineates a northwest-trending belt of contact tungsten deposits which runs from the Lava Creek mining district northwest to the Big Creek mining district in northern Valley County. The tungsten occurs as scheelite or powellite in calcareous rocks which have been thermally metamorphosed by nearby intrusive bodies.

Most authors who have discussed the genesis of the metallic mineral deposits typical of south-central Idaho emphasize the association of the mineral deposits with intrusive rocks and structures. Ruppel (1978, 1982) concludes that most of the major mineral deposits in east-central Idaho were genetically associated with neck-like, central stocks which rose along steep reverse faults. These stocks fed magma laterally along the imbricate thrust faults resulting in the formation of sheet-like bodies (Ruppel, 1982). Bennett (1980) proposes that convective hydrothermal systems were formed around epizonal Tertiary plutons. Such a concept is supported by Hall et al. (1978) in their geochemical study of the Wood River district. They conclude that the mineral deposits in the district formed by leaching of metals from Paleozoic country rocks and redeposition in favorable structural settings. The distribution of most of the known mineralization in the Pioneer Mountains GRA does appear to be spatially associated with Tertiary intrusives; thus; similar undiscovered deposits associated with buried intrusives may exist at depth. Aeromagnetic data covering the northwest

part of the GRA, including WSA 53-4 and 53-5, shows a strong northwest-trending magnetic high which includes the Muldoon stock (Mabey, 1981). The gentle slope of the southeast end of the anomaly suggests that the nose of the stock may extend beneath the northwest part of WSA 53-5. The geochemical anomalies in the area between Muldoon Canyon and Friedman Creek are within the area that may be underlain by the nose of the pluton. A second magnetic peak occurs on the northwest-trending magnetic high near the confluence of Muldoon and Copper Creeks. Mabey (1981) interprets this peak to be a shallow stock. Both stocks are interpreted to be parts of a much larger northwest-trending pluton underlying the large magnetic high (Mabey, 1981).

The sedimentary rocks underlying the Pioneer Mountains GRA were deposited in continental margin and continental rise and continental rise setting. Major metallic mineral deposit types expected in this setting are carbonate or sandstone-hosted lead-zinc deposits and metalliferous black shale/argillite deposits (Mitchell and Garson, 1981).

The carbonate or sandstone-hosted lead-zinc deposits in this setting are collectively known as Mississippi Valley-type mineralization which is generally characterized by the following:

1. simple sulfide mineralogy
2. generally hosted by dolomites, less commonly by sandstones or limestones
3. absence of nearby intrusive rocks
4. mineralization related to local facies changes in host rock

5. districts related to basinal margins
6. relatively simple structure at time of deposition

The Paleozoic ages of leads from the Wood River district (Hall et al., 1978), the general characteristics of some of the lead-zinc mineralization in east-central Idaho, and the presence of stratabound lead and copper mineralization in Cambrian rocks in southeastern Idaho (Mansfield, 1927) suggest regional potential for Mississippi Valley-type mineralization in the older continental margin setting of east-central Idaho.

Although the allochthonous nature of the terrane within the Pioneer Mountains GRA obscures the facies relationships among the sediments, both breccias and reef complexes, which are excellent ore hosts elsewhere, may be present in the Paleozoic carbonates. If Mississippi Valley-type lead-zinc mineralization is present in east-central Idaho, then some of the known lead-zinc occurrences may represent remobilization of undiscovered mineralization during later geologic processes, particularly via ground water migration along fractures and faults and via hydrothermal convection due to igneous intrusion.

Silver-lead-zinc mineralization is sometimes associated with argillitic turbidite sequences. An example of this type of mineralization occurs in the eastern Selwyn basin in the Yukon Territory where stratiform silver-lead-zinc mineralization occurs in a sequence of argillites, limestones, sandstones and conglomerates. Barite is often present as an accessory mineral and barium halos commonly surround the centers of lead-zinc-silver mineralization (Carne, 1976). Simons (1981) did not find the black shales/

argillites in the Boulder-Pioneer study area to be notably enriched in metals, but he did find that the lower clastic unit of the Copper Basin Formation contains unusually large amounts of barium. This suggests that some potential for stratiform silver-lead-zinc mineralization may exist in the Late Devonian and Early Mississippian argillite sequences.

There are no known uranium occurrences in the Pioneer Mountains GRA. A hydrogeochemical and stream geochemical sampling program was conducted in the Hailey NTMS Quadrangle, but only the analytical results from this program have been released. Without location maps the data could not be used in this study. However in the Beaverhead Range, the McGowan Creek Formation was found to be uraniferous (Wodzicki and Krason, 1981). This unit is present in the GRA, but no data is available on the uranium content of the McGowan Creek Formation within the Pioneer and White Knob Mountains.

The Pioneer Mountains GRA is a part of the Cordilleran fold-thrust belt. Major hydrocarbon reserves are present 175 miles southeast of the GRA in western Wyoming where three giant oil fields (Lamb, 1980; McCaslin, 1981) and 12 other fields are currently being developed. Some of the latter may be classed in the giant ranks when fully developed. Production within this area is from several horizons including Ordovician, Devonian, Mississippian, Pennsylvanian, Triassic, and Jurassic units (McCaslin, 1980, 1981). In the Pioneer Mountains GRA most of these Paleozoic units have equivalents, but Triassic and Jurassic rocks are not present. Production is also known from the Thrust belt in west-central Montana, approximately 365 miles north of the Pioneer Mountains GRA. Several geologists have indicated that the

Thrust belt structural province extending from southeastern Idaho and southwestern Wyoming continues into east-central Idaho and southwestern Montana (King, 1969; Blackstone, 1977; Ruppel et al., 1981). Potential hydrocarbon source beds in the Pioneer Mountains GRA are the dark shales of the Milligen and McGowan Creek Formations, argillaceous limestones and calcareous shales of the Jefferson Formation, and dark clayey-silty limestones of the South Creek Formation. All of these units except the South Creek Formation have had hydrocarbon analyses made on them from localities in east-central Idaho or southwestern Montana. A petroleum company had samples of the McGowan Creek Formation from the White Knob and Lost River Ranges analyzed. The results of these analyses indicate that the unit has a mature, very poor oil, good to excellent wet-gas condensate source character (Nance Petroleum, pers. comm., 1982). Minor source beds could occur in the shaly limestones of the White Knob and Wood River Formations; however, insufficient studies of these units have been made to verify the hydrocarbon source potential.

Potential reservoir beds in the Paleozoic section include sucrosic dolomite in the Ordovician should it be present at depth, vuggy Silurian Laketown Dolomite, fractured carbonates of Ordovician and younger age, and sandstones of late Paleozoic age. Samples of vuggy Laketown Dolomite collected in the northern part of the White Knob Mountains would make excellent hydrocarbon reservoirs given the proper structural conditions (Nance Petroleum, pers. comm., 1982). Insufficient studies have been made of the units underlying the Pioneer Mountains GRA to quantify reservoir characteristics of any of the formations underlying the area.

Structural traps in the Pioneer Mountains GRA are not defined at present. The presence imbricated thrust plates in the area (Skipp and Hait, 1977) as well as the existence of anticlinal folds, (Nelson and Ross, 1969) and high angle faulting (Ruppel, 1982) suggests that excellent structural traps should be present in the subsurface of the Pioneer Mountains GRA. In addition, magnetic and seismic data suggests that structural traps are present in WSA 31-14 and 31-17 (Nance Petroleum, pers. comm., 1982).

Considering that commercial production exists in the Thrust belt both sides of the Pioneer Mountains GRA and that the GRA is part of this major structural belt, oil and gas potential in the GRA is good. However, until the area is tested by drilling it will remain unknown whether or not commercial hydrocarbon deposits are present.

There are no known hot springs or other geothermal manifestations in the Pioneer Mountains GRA; therefore, the geothermal potential of the area must be evaluated by analogy based on the regional setting. The Pioneer Mountains GRA is within the Central Idaho Basin and Range geothermal province which occupies the area between the Idaho batholith on the west, the Montana Basin and Range province on the east, and the Snake River Plains on the south. The area is distinguished from the Montana Basin and Range in that the bedrock of the province is predominately Precambrian and Paleozoic sedimentary rocks which have been extensively thrust faulted. Except for a few outliers of basalt along the margin of the Snake River Plain, the Eocene Challis Volcanics are the youngest volcanic rocks exposed in this province. Normal faulting appears to have been active until very recent times. In addition, a seismic trend extending westward from Yellowstone National Park

passes through the center of the province. Another zone of seismic activity is present just west of the Central Idaho Basin and Range geothermal province and an east-west trend of seismic activity is also present along the Centennial Mountains on the Montana border just east of the province (Smith, 1978). The hot spring frequency in the Central Idaho Basin and Range geothermal province is somewhat lower than in the Montana and Basin Range province; however, the Central Idaho basin and Range province is virtually unknown on even a reconnaissance geothermal or geophysical basis. Typical heat flow values are probably the same as the Montana Basin and Range province, but very little data is available. Due to the abundance of carbonate rocks in the province, the hydrology is probably more complicated than in the Montana Basin and Range province where less permeable granitic and metamorphic rocks predominate. However, it is not possible to predict the influence that bedrock hydrology might have on the location of geothermal systems in the Central Idaho Basin and Range province using existing data.

There are no wells with thermal gradient information in the immediate vicinity of the Pioneer Mountains GRA. South of Timbered Dome, a 360 foot deep well has a surface temperature of 43.5°C. Wells at Butte City, 10 miles southeast of Appendicitis Hill, may have temperatures as high as 76°C at a depth of 86 feet. These wells are along the boundary between the Snake River Plain and the Central Idaho Basin and Range geothermal provinces (Mitchell et al., 1980). The geothermal setting northwest of this boundary is probably typical of that throughout the Central Idaho Basin and Range geothermal province.

## 3.6 Mineral and Energy Economics

There are good gravel roads throughout most of the Pioneer Mountains GRA and adequate water sources. These factors combine to make mineral development in the GRA economically attractive given a suitable deposit.

The rise in the price of silver in the late 1970s spurred considerable exploration interest. U.S. market demand has steadily increased as more industrial uses for silver are found (Rosta, 1982). Silver deposits formerly considered to be low grade are now economically attractive at present prices. Additionally, recoverable silver values in base metal ores, e.g. lead or copper, now make a substantial contribution to mine profits.

With the increase in the price imported oil in the past decade, the deregulation of domestic natural gas prices, and increasing government emphasis on energy self sufficiency, exploration and development of domestic oil and gas resources has proceeded at an accelerated pace. Natural gas reserves discovered in the late 1950s and 1960s were often not developed because of a lack of market (Heany, 1961). However, under present conditions drilling is taking place with a goal of near-term production.

The economic feasibility of geothermal resource development is determined by its distance to market and its temperature. Long-distance transportation of lower temperature geothermal energy is not feasible whereas for electrical grade resources long transportation distances are feasible. Based on present requirements for the use of hot fluids in electrical generating techniques, geothermal systems with temperatures of less than 150°C do not

have significant potential for electrical exploitation. However, geothermal resources with temperatures less than 150°C do have significant potential for low and intermediate temperature geothermal utilization for space heating, material processing, etc. if their minimum temperature exceeds 40°C. At the lower end of the spectrum, as the energy content of the resource becomes less, or the drilling depth necessary for exploitation becomes greater, there is a very ill-defined cutoff. For example, shallow ground water temperatures on the order of 10-20°C can be used for heat pump applications, and in some cases these are considered geothermal resources. However, in this evaluation, a lower temperature than approximately 40°C is considered uneconomic as a geothermal resource.

# 4.0 LAND CLASSIFICATION FOR GEM RESOURCES POTENTIAL

## 4.1 Explanation of Classification Scheme

In the following sections the land in the WSAs within the Pioneer Mountains GRA is classified for geology, energy and mineral (GEM) resources potential. The classification scheme used is shown in Table V. Use of this scheme is specified in the contract under which WGM prepared this report.

The evaluation of resource potential and integration into the BLM classification system has been done using a combination of simple subjective and complex subjective approaches (Singer and Mosier, 1981) to regional resources assessment. The simple subjective approach involves the evaluation of resources based on the experience and knowledge of the individuals conducting the evaluations. The complex subjective method involves use of rules, i.e. geologic inference, based on expert opinion concerning the nature and importance geologic relationships associated with mineral and energy deposits (Singer and Mosier, 1981).

The GEM evaluation is the culmination of a series of tasks. The nature and order of the tasks was specified by the BLM, however they constitute the general approach by which most resource evaluations of this type are conducted. The sequence of work was: (1) data collection, (2) compilation, (3) evaluation, and (4) report preparation. Two days of field work were done in the Pioneer Mountains GRA.

TABLE VI

BUREAU OF LAND MANAGEMENT GEM RESOURCES LAND CLASSIFICATION SYSTEM

CLASSIFICATION SCHEME

1. The geologic environment and the inferred geologic processes do not indicate favorability for accumulation of mineral resources.

2. The geologic environment and the inferred geologic processes indicate low favorability for accumulation of mineral resources.

3. The geologic environment, the inferred geologic processes, and the reported mineral occurrences indicate moderate favorability for accumulation of mineral resources.

4. The geologic environment, the inferred geologic processes, the reported mineral occurrences, and the known mines or deposits indicate high favorability for accumulation of mineral resources.

LEVELS OF CONFIDENCE

A. The available data are either insufficient and/or cannot be considered as direct evidence to support or refute the possible existence of mineral resources within the respective area.

B. The available data provide indirect evidence to support or refute the possible existence of mineral resources.

C. The available data provide direct evidence, but are quantitatively minimal to support or refute the possible existence of mineral resources.

D. The available data provide abundant direct and indirect evidence to support or refute the possible existence of mineral resources.

Each WSA is classified for locatable, leasable, and saleable resources potential.

Locatable minerals are those which are locatable under the General Mining Law of 1872, as amended, and the Placer Act of 1870, as amended. Minerals which are locatable under these acts include metals, ores of metals, non-metallic minerals such as asbestos, barite, zeolites, graphite, uncommon varieties of sand, gravel, building stone, limestone, dolomite, pumice, pumicite, clay magnesite, silica sand, etc. (Maley, 1983).

Leasable resources include those which may be acquired under the Mineral Leasing Act of 1920 as amended by the Acts of 1927, 1953, 1970, and 1976. Materials covered under this Act include: asphalt, bitumen, borates of sodium and potassium, carbonates of sodium and potassium, coal, natural gas, nitrates of sodium and potassium, oil, oil shale, phosphate, silicates of sodium and potassium, sulfates of sodium and potassium, geothermal resources, etc. (Maley, 1983).

Saleable resources include those which may be acquired under the Materials Act of 1947 as amended by the Acts of 1955 and 1962. Included under this Act are common varieties of sand, gravel, stone, cinders, pumice, pumicite, clay, limestone, dolomite, peat and petrified wood (Maley, 1983).

## 4.2 Classification of the Appendicitus Hill (31-14) WSA

### 4.2.1 Locatable Resources

4.2.1a Metallic Minerals. The Appendicitus Hill WSA (1a, Fig. 17) is classified as having low to moderate favorability for metallic mineral resources, but the available data is insufficient for an adequate evaluation (2A-3A). The low confidence rating is assigned because of the low level of detail of published geologic mapping and the lack of geochemical and geophysical data.

4.2.1b Uranium and Thorium. WSA 31-14 (1b, Fig. 17) is classified as having low favorability for uranium and thorium based on inadequate data (2A). No occurrences are known, but the data base is sparse. The classification should be higher if the McGowan Creek Formation is found to be uraniferous.

4.2.1c Non-Metallic Minerals. All of WSA 31-14 (1c, Fig. 17) is classifed as having low to moderate potential for barite, but the available data is insufficient for an adequate evaluation (2A-3A). The low level of confidence is assigned because of the low level of detail of available geologic mapping and the lack of geochemical and geophysical data.

### 4.2.2 Leasable Resources

4.2.2a Oil and Gas. All of WSA 31-14 (1 and 2, Fig. 18) is classifield as having moderate favorability for oil and gas based on limited direct

## Pioneer Mountains GRA, Idaho
## Legend For Figure 17

*BLM LAND CLASSIFICATION SYSTEM FOR GEM RESOURCES*

### CLASSIFICATION SCHEME

1. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES DO NOT INDICATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.
2. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES INDICATE LOW FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.
3. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, AND THE REPORTED MINERAL OCCURRENCES INDICATE MODERATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.
4. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, THE REPORTED MINERAL OCCURRENCES, AND THE KNOWN MINES OR DEPOSITS INDICATE HIGH FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

### LEVELS OF CONFIDENCE

A. THE AVAILABLE DATA ARE EITHER INSUFFICIENT AND/OR CANNOT BE CONSIDERED AS DIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES WITHIN THE RESPECTIVE AREA.

B. THE AVAILABLE DATA PROVIDE INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

C. THE AVAILABLE DATA PROVIDE DIRECT EVIDENCE, BUT ARE QUANTITATIVLEY MINIMAL TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

D. THE AVAILABLE DATA PROVIDE ABUNDANT DIRECT AND INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

### EXPLANATION

Area I.D. Number

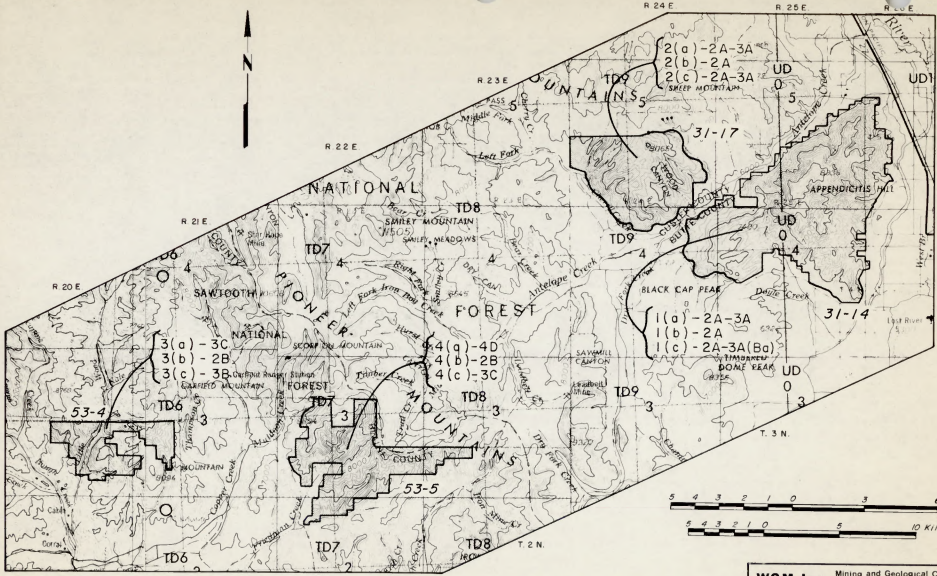
1(a)- 4D

Level of Confidence

Commodity

Classificotion

a) Metallic Minerals
b) Uranium and Thorium
c) Non-Metallic Minerals




Approximate Boundary of Wilderness Study Area.

**WGM Inc.** Mining and Geological Consultants
Anchorage, Alaska

**BLM GEM RESOURCES ASSESSMENT**
REGION 2 NORTHERN ROCKY MOUNTAINS

## *Pioneer Mountains, Idaho*

***Wilderness Study Area***
***Land Classification***
***Locatable Resources***

| | | |
|---|---|---|
| SCALE: 1" = 4 MILES (1:250,000) | | FIGURE |
| DATA BY: WGM | DATE: 9/1982 | 17 |
| DRAWN BY: DSI | APPRVD: G.K. | |

**Pioneer Mountains GRA, Idaho**
**Legend For Figure 18**

## *BLM LAND CLASSIFICATION SYSTEM FOR GEM RESOURCES*

### CLASSIFICATION SCHEME

1. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES DO NOT INDICATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

2. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES INDICATE LOW FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

3. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, AND THE REPORTED MINERAL OCCURRENCES INDICATE MODERATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

4. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, THE REPORTED MINERAL OCCURRENCES, AND THE KNOWN MINES OR DEPOSITS INDICATE HIGH FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

### LEVELS OF CONFIDENCE

A. THE AVAILABLE DATA ARE EITHER INSUFFICIENT AND/OR CANNOT BE CONSIDERED AS DIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES WITHIN THE RESPECTIVE AREA.

B. THE AVAILABLE DATA PROVIDE INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

C. THE AVAILABLE DATA PROVIDE DIRECT EVIDENCE, BUT ARE QUANTITATIVLEY MINIMAL TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

D. THE AVAILABLE DATA PROVIDE ABUNDANT DIRECT AND INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

### EXPLANATION

Area I.D. Number

1(a)- 4D

Level of Confidence

Commodity

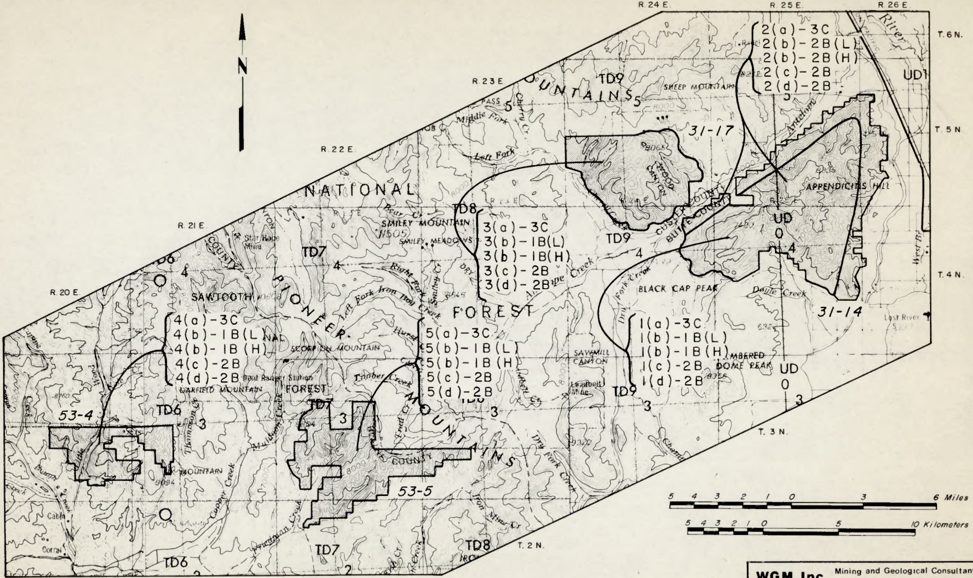
Classification

a) oil and gas

b) Geothermal: high temperature (H), Low temperature (L)

c) Sodium and Potassium

d) others: Asphalt (As) bitumen (bt), phosphate (ph), No specific commodity designation indicates that the rating applies to all of the above.




Approximate Boundary of Wilderness Study Area.

**WGM Inc.** Mining and Geological Consultants
Anchorage, Alaska

BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

***Pioneer Mountains, Idaho***

***Wilderness Study Area***
***Land Classification***
***Leasable Resources***

| SCALE: 1" = 4 MILES (1:250,000) | | | FIGURE |
|---|---|---|---|
| DATA BY: WGM | DATE: 9/1982 | REVISED | **18** |
| DRWN BY: DSI | APRVD: G.F. | | |

evidence (3C). The basis of this classification is the structural setting of the WSA including excellent potential for the development of traps, indications of subsurface structures from private geophysical data, the presence of potential hydrocarbon source and reservoir beds in the stratigraphic section, and a favorable thermal history of the source rocks.

4.2.2b Geothermal. Most of WSA 31-14 (1, Fig. 18) is classified as being unfavorable for geothermal resources based on indirect evidence (1B). The portions of WSA 31-14 along Antelope Creek and Lost River Valleys (2, Fig. 18) are classified as having low favorability for geothermal resources based on indirect evidence (2B). The 1B classification is based on analogy with similar areas in the Idaho Basin and Range geothermal province and the high elevations present combined with the absence of major faults or lineaments. The 2B classification is based on proximity to the northern margin of the Snake River Plain, the existence of a range-bounding fault along the east side of the WSA, and the presence of a major lineament along Antelope Creek.

4.2.3c Sodium and Potassium. All of WSA 31-14 (1 and 2, Fig. 18) is classified as having low favorability for sodium and potassium based on indirect evidence (2B). The basis of the classification is the generally unfavorable geologic environment present in the WSA and the lack of known occurrences in the region.

4.2.3d Other. WSA 31-14 (1 and 2, Fig. 18) is classified as having low favorability for other leasable resources, including phosphate, bitumen, and asphalt based on indirect evidence (2B). The basis of this classification

is the lack of known occurrences in the area and the generally unfavorable geologic environment of the WSA.

4.2.3 Saleable Resources

WSA 31-14 (1, Fig. 19) is classified as having moderate favorability for common varieties of limestone based on indirect evidence (3B). The basis of the classification is the dominance of carbonate rocks in the stratigraphic section. The lack of detailed geologic mapping in the area precludes a more site-specific classification.

4.3 Classification of the White Knob Mountains (31-17) WSA

4.3.1 Locatable Resources

4.3.2a Metallic Minerals. All of WSA 31-17 (2a, Fig. 17) is classified as having low to moderate favorability for metallic mineral resources, but the available data is insufficient for an adequate evaluation (2A-3A). The low confidence rating is assigned because of the low level of detail of published geologic mapping and the lack of geochemical and geophysical data.

4.3.1b Uranium and Thorium. WSA 31-17 (2b, Fig. 17) is classified as having low favorability for uranium and thorium based on inadequate evidence (2A). No occurrences are known, but the classification should be higher if uraniferous McGowan Creek Formation is present in the WSA.

## Pioneer Mountains GRA, Idaho
## Legend For Figure 19

### *BLM LAND CLASSIFICATION SYSTEM FOR GEM RESOURCES*

#### CLASSIFICATION SCHEME

1. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES DO NOT INDICATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

2. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES INDICATE LOW FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

3. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, AND THE REPORTED MINERAL OCCURRENCES INDICATE MODERATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

4. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, THE REPORTED MINERAL OCCURRENCES, AND THE KNOWN MINES OR DEPOSITS INDICATE HIGH FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

#### LEVELS OF CONFIDENCE

A. THE AVAILABLE DATA ARE EITHER INSUFFICIENT AND/OR CANNOT BE CONSIDERED AS DIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES WITHIN THE RESPECTIVE AREA.

B. THE AVAILABLE DATA PROVIDE INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

C. THE AVAILABLE DATA PROVIDE DIRECT EVIDENCE, BUT ARE QUANTITATIVLEY MINIMAL TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

D. THE AVAILABLE DATA PROVIDE ABUNDANT DIRECT AND INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

#### EXPLANATION

Area I.D. Number

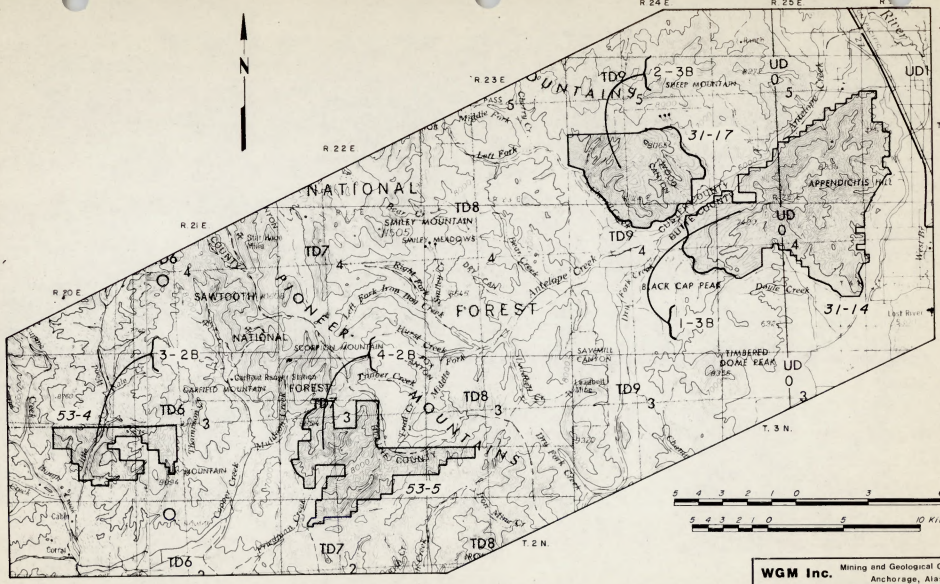
I(Ls)- 4D

Level of Confidence

Commodity

Classification

| | |
|---|---|
| s | Sand |
| g | Gravel |
| st | Stone |
| c | Cinders |
| p | Pumice |
| pt | Pumicite |
| cl | Clay |
| Ls | Limestone |
| dl | Dolomite |
| P | Peat |
| pw | Petrified wood |




Approximate Boundary of Wilderness Study Area.

**WGM Inc.** Mining and Geological Consultants Anchorage, Alaska

BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

***Pioneer Mountains, Idaho***
***Wilderness Study Area***
***Land Classification***
***Saleable Resources***

| | | | |
|---|---|---|---|
| SCALE: 1" = 4 MILES (1:250,000) | | | FIGURE |
| DATA BY: WGM | DATE: 9/1982 | REVISED | 19 |
| DRWN BY: DSI | APRVD: G.F. | | |

4.3.1c Non-metallic Minerals. WSA 31-17 (2c, Fig. 17) is classified as having low to moderate potential for barite, but the available data are insufficient for an adequate evaluation (2A-3A). The low level of confidence is assigned because of the low level of detail of available geologic mapping and the lack of geochemical and geophysical data.

4.3.2 Leasable Resources

4.3.2a Oil and Gas. All of WSA 31-17 (3, Fig. 18) is classified as having moderate favorability for oil and gas based on limited direct evidence (3C). The basis of this classification is the structural setting of the WSA including excellent potential for development of traps, indications of subsurface structures in priviate geophysical data, the presence of hydrocarbon source and reservoir beds in the stratigraphic section, and the favorable thermal history of the source rocks.

4.3.2b Geothermal. All of the area of WSA 31-17 (3, Fig. 18) is classified as being unfavorable for geothermal resources based on indirect evidence (1B). The classification is based analogy with simliar areas with the Idaho Basin and Range province. Negative factors include generally high elevations and an absence of major faults or lineaments.

4.3.2c Sodium and Potassium. All of WSA 31-17 (3, Fig. 18) is classified as having low favorability for sodium and potassium based on indirect evidence (2B). The basis of the classification is the generally unfavorable geologic environment of the WSA and the lack of known occurrences in the region.

4.3.2d Other. WSA 31-17 (3, Fig. 18) is classified as having low favorability for other leasable resources, including phosphate, bitumen, and asphalt based on indirect evidence (2B). The basis of this classification is the lack of known occurrences in the area and the generally unfavorable geologic environment of the WSA.

4.3.3 Saleable Resources

WSA 31-17 (2, Fig. 19) is classified as having moderate favorability for common varieties of limestone based on indirect evidence(3B). The basis of the classification is the dominance of carbonate rocks in the stratigraphic section. The lack of detailed geologic mapping in the area precludes a more site-specific classification.

4.4 Classification of the Little Wood River (53-4) WSA

4.4.1 Locatable Resources

4.4.1a Metallic Minerals. WSA 53-4 (3, Fig. 17) is classified as having moderate favorability for metallic minerals based on limited direct evidence (3C). The basis of this classification is the favorable geologic setting of the WSA, the presence of known mineral occurrences, and favorable geophysical data.

4.4.1b Uranium and Thorium. WSA 53-4 (3b, Fig. 17) is classified as having low favorability for uranium and thorium based on indirect evidence (2B). The basis for the classification is the absence of known occurrences.

4.4.1c Non-Metallic Minerals. All of WSA 53-4 (3c, Fig. 17) is classified as having moderate potential for barite based on indirect evidence (3B). The low level of confidence is assigned because of the low level of detail of the available geological mapping and the lack of geochemical data.

4.4.2 Leasable Resources

4.4.2a Oil and Gas. WSA 53-4 (4, Fig. 18) is classified as having moderate favorability for oil and gas based on limited direct evidence (3C). The basis of this classification is the favorable structural setting of the WSA including excellent potential for development of traps, indications of subsurface structures in private geophysical data, the presence of hydrocarbon source and reservoir beds in the stratigraphic section, and the favorable thermal history of the source rocks.

4.4.2b Geothermal. WSA 53-4 (4b, Fig. 18) is classified as being unfavorable for geothermal resources based on indirect evidence (1B). The basis of the classification is by analogy with simlar areas in the Idaho Basin and Range geothermal province. The WSA is mainly at high elevations and major faults or lineaments are absent.

4.4.2c Sodium and Potassium. WSA 53-4 (4c, Fig. 18) is classified as having low favorability for sodium and potassium based on indirect evidence (2B). The basis of the classification is the generally unfavorable geologic environment of the WSA and the lack of known occurrences in the region.

4.4.2d Other. WSA 53-4 (4d, Fig. 18) is classified as having low favorability for other leasable resources, including phosphate, bitumen, and asphalt based on indirect evidence (2B). The basis of this classification is the lack of known occurrences in the area and the generally unfavorable geologic environment of the WSA.

### 4.4.3 Saleable Resources

The entire area of WSA 53-4 (3, Fig. 19) is classified as having low favorability for saleable resources based on indirect evidence (2B).

## 4.5 Classification of the Friedman Creek (53-5) WSA

### 4.5.1 Locatable Resources

4.5.1a Metallic Minerals. WSA 53-5 (4a, Fig. 17) is classified as having high favorability for metallic minerals based on abundant direct evidence (4D). The basis of this classification is the immediate proximity and geologic similarity of the WSA to an adjacent mineral district, the trend of mineralized structures into the WSA, and the numerous geochemical anomalies present in the WSA.

4.5.1b Uranium and Thorium. WSA 53-5 (4b, Fig. 17) is classified as having low favorability for uranium and thorium resources based on indirect evidence (2B). The basis for this classification is the absence of known occurrences.

4.5.1c Non-Metallic Minerals. WSA 53-5 (4c, Fig. 17) is classified as having moderate favorability for barite based on limited direct evidence (3C). The basis of this classification is the presence of barite mineralization and barium geochemical anomalies adjacent to the WSA, and the similarity of the geology within the WSA to that of the area surrounding the Muldoon barium deposits.

4.5.2 Leasable Resources

4.5.2a Oil and Gas. WSA 53-5 (4, Fig. 18) is classified as having moderate favorability for oil and gas based on limited direct evidence (3C). The basis of this classification is the structural setting of the WSA including excellent potential for development of traps, indications of subsurface structures in private geophysical data, the presence of hydrocarbon source and reservoir beds in the stratigraphic section, and the favorable thermal history of the source rocks.

4.5.2b Geothermal. All of WSA 53-5 (5, Fig. 18) is classified as being unfavorable for geothermal resources based on indirect evidence (1B). The basis of the classification is by analogy with similar areas in the Idaho Basin and Range province. The area is mostly at high elevations and major faults or lineaments are absent.

4.5.2c Sodium and Potassium. WSA 53-5 (5, Fig. 18) is classified as having low favorability for sodium and potassium based on indirect evidence (2B). The basis of the classification is the generally unfavorable geologic environment of the WSA and the lack of known occurrences in the region.

4.5.3d Other. WSA 53-5 (5, Fig. 18) is classified as having low favorability for other leasable resources, including phosphate, bitumen, and asphalt based on indirect evidence (2B). The basis of this classification is the lack of known occurrences in the area and the generally unfavorable geologic environment of the WSA.

4.5.4 Saleable Resources

The entire area of WSA 53-5 (4, Fig. 19) is classified as having low favorability for saleable resources based on indirect evidence (2B).

## 5.0 RECOMMENDATIONS FOR FURTHER WORK

The eastern part of the Pioneer Mountains GRA needs to be mapped at a minimum scale of 1:62,500. Available mapping is at reconnaissance scales and was completed at a time when the stratigraphy was not as well understood as today. More detailed mapping of the area would improve the evaluation for oil and gas, metallic minerals and geothermal resources.

The NURE data from the Idaho Falls Quadrangle should be integrated into the data base upon release of the report.

Geochemical stream sediment samples should be collected from the streams draining WSAs 31-14, 31-17 and 53-4 to increase the data base and improve the level of confidence in the mineral assessment. Samples should be collected at a density of 1 to 2 samples per square mile. The samples should be analyzed for copper, lead, zinc, molybdenum, and uranium. During this program the McGowan Creek Formation should also be sampled for uranium.

The base data available on WSA 53-5 are sufficient. More specific evaluation should be completed. This work should include analyses of the samples collected for barium and molybdenum and geological mapping of the WSA and the adjacent Muldoon Canyon area at a scale of 1:24,000. The mapping should be accompanied by detailed rock geochemical sampling.

The hydrocarbon assessment would be upgraded by the completion of the following:

1. Potential hydrocarbon source beds within the Pioneer Mountains GRA should be sampled and analyzed for hydrocarbons. The results would indicate the types of hydrocarbons that might be expected within the area. It would also provide a thermal maturity history of the area.

2. Analyses of potential reservoir beds should be made. These studies will aid in the location of more favorable traps.

3. Conodont color alteration index studies should be made of all Paleozoic carbonates in the Pioneer Mountains GRA. This will provide a thermal maturation history of the Paleozoic stratigraphic section and help indicate the types of hydrocarbons generated in the area.

4. Geophysical studies should be made of the region. This will provide a better structural interpretation within the region and will help select the most favorable traps and drill sites.

Most of these recommended oil and gas studies will probably be conducted, if not already completed, by industrial firms if hydrocarbon exploration continues within the area.

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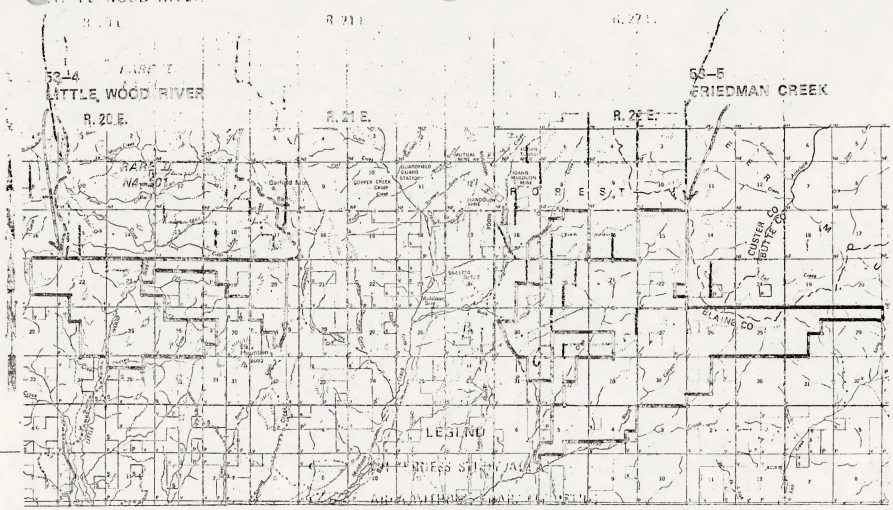
# APPENDIX I

# WILDERNESS STUDY AREA MAPS




LEGEND

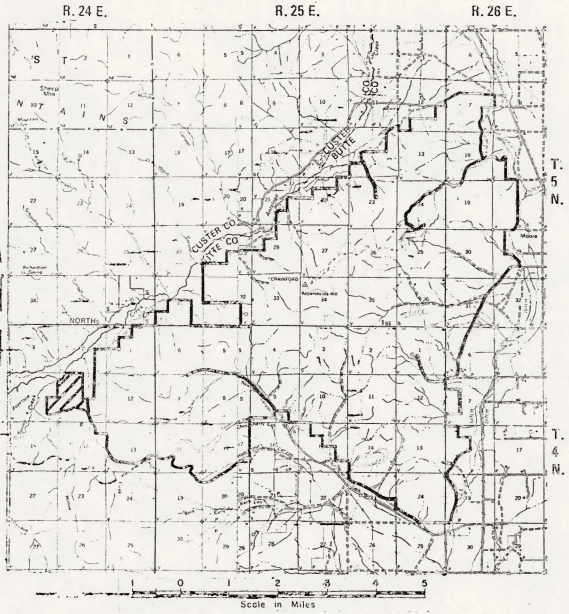
WILDERNESS STUDY AREA

AREA WITHOUT CHARACTERISTICS

0 1 2 3 4 5

Scale in Miles

31-14
APPENDICITIS HILL

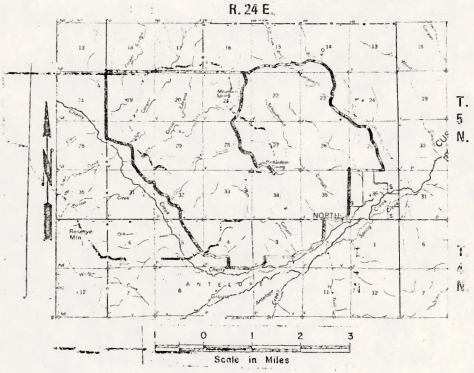



LEGEND

WILDERNESS STUDY AREA

AREA WITHOUT CHARACTERISTICS

31--17
WHITE KNOB MOUNTAINS




LEGEND

WILDERNESS STUDY AREA

AREA WITHOUT CHARACTERISTICS

# APPENDIX II

# FIELD VISIT REPORT

WGM Inc.

To: Pioneer Mountains GRA File
Fm: Greg Fernette, Bill Jones

Subject: Visit to GRA - October 12 and 13, 1982

The Muldoon mine in Muldoon Canyon was visited since similar mineralization may exist in the nearby Friedman Creek WSA. The WSA was also visited and work performed along with significant observations are summarized below:

Muldoon Mine

Mineralization at the mine consists of coarse pyrite, sphalerite and some chalcopyrite and specular hematite. The sulfides occur in veins and breccia zones associated with altered hypabyssal(?) porphyritic dacite dikes which have intruded along a fault zone trending about N50W. The country rocks are quartzites with lesser conglomerate and shale. The trend of the mineralized zone projects into the Friedman Creek WSA.

Friedman Creek WSA

Traverses were made up of the drainages and along some ridges in the WSA to examine the geology and collect stream sediment samples. Thirty-three samples were collected. These samples were sent to Rainbow Resource Laboratories in Anchorage for analysis. The WSA is underlain mainly by quartzites with some shale and conglomerate, capped by Challis Volcanics. Altered dikes and mineralized talus similar to the rocks at the Muldoon mine were found in several places.

# APPENDIX III

## ANALYTICAL DATA FOR GEOCHEMICAL SAMPLES COLLECTED IN THE FRIEDMAN CREEK WSA

WGM Inc.

| Sample No. | Sample Type | Cu (ppm) | Pb (ppm) | Zn (ppm) | Ag (ppm) | Au (ppm) |
|---|---|---|---|---|---|---|
| 28013 | SS | 40 | 95 | 135 | 1.0 | .04 |
| 28014 | SS | 55 | 45 | 345 | 4.0 | .02 |
| 28015 | SS | 65 | 50 | 195 | 2.2 | .02 |
| 28016 | SS | 95 | 50 | 135 | 2.2 | .02 |
| 28017 | SS | 40 | 65 | 110 | .4 | .02 |
| 28018 | SS | 35 | 30 | 80 | .2 | .04 |
| 28019 | SS | 45 | 45 | 150 | .2 | .04 |
| 28020 | SS | 25 | 40 | 75 | .2 | .10 |
| 28030 | SS | 40 | 35 | 165 | 1.2 | .04 |
| 28031 | SS | 45 | 45 | 390 | .2 | .04 |
| 28032 | SS | 90 | 60 | 500 | 1.2 | .04 |
| 28033 | SS | 35 | 40 | 230 | 1.0 | .02 |
| 28034 | SS | 30 | 40 | 135 | .6 | .02 |
| 28035 | SS | 30 | 45 | 255 | .6 | .02 |
| 28036 | SS | 335 | 335 | 450 | 5.0 | .10 |
| 28037 | SS | 45 | 55 | 195 | 1.0 | .04 |
| 28041 | SS | 40 | 175 | 145 | 1.0 | .02 |
| 28042 | SS | 30 | 50 | 230 | .6 | .02 |
| 28043 | SS | 45 | 45 | 100 | 1.2 | .02 |
| 28044 | SS | 60 | 55 | 465 | 1.0 | .04 |
| 28045 | SS | 30 | 50 | 280 | .2 | .02 |
| 28046 | SS | 40 | 55 | 175 | .2 | .02 |
| 28047 | SS | 35 | 50 | 140 | .4 | .04 |
| 28048 | SS | 35 | 50 | 115 | .2 | .02 |
| 28049 | SS | 30 | 30 | 90 | .2 | .02 |
| 28050 | SS | 40 | 45 | 110 | .2 | .02 |
| 28051 | SS | 95 | 50 | 100 | .6 | .02 |
| 28052 | SS | 50 | 170 | 140 | .8 | .02 |
| 28053 | SS | 30 | 75 | 100 | .2 | .02 |
| 28054 | SS | 40 | 40 | 90 | .2 | .02 |
| 28055 | SS | 45 | 35 | 465 | .4 | .02 |
| 28056 | SS | 140 | 60 | 150 | 1.0 | .02 |
| 28057 | SS | 45 | 40 | 400 | .4 | .02 |

Atomic absoprtion analyses by Rainbow Resource Laboratories, Anchorage, Alaska.

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